Diplomarbeit

Titel der Arbeit

Automatic Processing of Space and Valence in a Semantic Categorization Task

Verfasserin

Daniela Egerer

Angestrebter akademischer Grad

Magistra der Naturwissenschaften (Mag. rer. nat.)

Wien, im August 2012

Studienkennzahl:	298
Studienrichtung:	Psychologie
Betreuer:	Univ.-Prof. Dr. Ulrich Ansorge

“Thus, language use is a domain where the study of symbolic operations, statistical processing, and grounding can be integrated.” (Barsalou, 2008, p.633)

Acknowledgments

I would like to dedicate this thesis to the loved ones who are no longer able to travel life's road by my side, but who will always stay with me no matter where I go.

I would also like to use this opportunity to thank Univ.-Prof. Dr. Ulrich Ansorge for his continued support, for the time he took to help me especially when things became tricky, and for his patience and readiness to make this daunting task a little less daunting. I would also like to thank Shah Khalid for his assistance, especially in the more technical aspects of the experiment.

I would like to thank all my friends for always being there, for lending me their ears, and giving me their advice. I thank them for being a part of my life and sharing theirs with me.

Specifically, I want to thank my study-buddy Fanny, with whom I bonded toiling over statistical calculations in my first year at the University of Vienna, and who has become a dear friend that has helped me with university- and life-tribulations ever since. I would also like to thank my friend Nadine who has been an unwavering presence in my life. Without her I might not even have made it through high school.

Special thanks go to my friend Nikki, for sharing countless happy moments, for being a part of my life, and for a friendship that is undaunted by distance. She has taught me many life lessons. The most important one is that I do not always need to try to be perfect. I know that I can always lean on her.

I would also like to thank my brother for looking out for his little sister, and for helping me through childhood and take many steps later on in adulthood.

Most of all I would like to thank my mother, who has always been by my side, and who wants nothing more than to see her children happy. Without her support, and the opportunities that she provided, I would probably never have been able to accomplish any of my goals. I can turn to her whenever I am lost, and not only does she help where she can, and lend comfort where needed, but she also has the ability to make me laugh even in the bleakest of situations. So for the strength, the comfort, and for all the laughs, I would like to thank her.

Abstract English

In English as in German there are many metaphors and idioms that link valence (positive/negative) to the vertical spatial axis (up/down) (e.g., *to be in high spirits* or *to feel down*). The present thesis explores the implications of such thematic clusters of metaphors, and endeavors to demonstrate that these metaphors stem from an underlying conceptual link between the concepts of *positive* and *upward* spatial dimension, and *negative* and *downward* spatial dimension. This connection can be explained both with the theories of *conceptual metaphor* as well as with the *embodied cognition theories*, which are detailed herein. The present thesis illustrates findings of past studies which have demonstrated this connection between positive and up, and negative and down, and aims to expand on them to show that this connection is activated and processed automatically. To this end the stimuli were presented in such a fashion, that the participants were not aware of them (i.e. subliminally). Furthermore, in an extension of these past studies, the present thesis examines whether the automatic processing of this conceptual link between the vertical spatial axis and valence, applies to semantic processing, that is, when both the meanings of the valence as well as the spatial dimensions are activated by using words as stimuli.

While the results of the present study indicate that there might be a unidirectional link between valence and space, they are not sufficiently conclusive to satisfactorily support the idea of an automatic activation of this conceptual link that is activated by valence words and spatial words. However, this does not mean that such a link does not exist. This thesis also examines the possibility that stimuli are directly associated with a certain response, and that these *stimulus-response compatibilities* could have confounded the results. Although, the findings show, that the stimulus-response compatibilities do not bias the results in a systematic fashion, they could have confounded the results all the same. Other potential confounding factors are explored as well in the hope of explaining the lack of more definitive results and offering an outlook for future studies.

Kurzfassung

In der deutschen wie auch in der englischen Sprache gibt es mehrere Metaphern und Redewendungen, welche eine Assoziation zwischen positiven und negativem Affekt, und der vertikalen räumlichen Ebene (oben/unten) aufweisen (e.g., *oben auf sein* oder *in ein tiefes Loch fallen*). Die vorliegende Diplomarbeit bemüht sich die Tragweite solch wiederholender thematischer Muster in Metaphern zu beleuchten, und zu belegen, dass sie auf Grund eines grundlegenden Zusammenhang zwischen *positiv* und *oben*, und zwischen *negativ* und *unten* bestehen. Dieser grundlegende Zusammenhang lässt sich anhand von philosophischen, psycholinguistischen und kognitiv-psychologischen Theorien erklären, die hier beleuchtet werden. Es wird auch auf vergangene Studien eingegangen die sich mit diesem Zusammenhang zwischen Affekt und der vertikalen räumlichen Ebene befassen, und diese werden als Ansatzpunkt für die vorliegende Studie verwendet. Das wesentliche Ziel ist es zu belegen, dass dieser Zusammenhang auch automatisch wahrgenommen und verarbeitet wird. Zu diesem Zweck wurden hier die Reize so dargeboten, dass die Versuchsteilnehmer sie nicht bewusst wahrnehmen konnten (also subliminal). Zudem bemüht sich die vorliegende Arbeit, die Erkenntnisse vorhergehender Studien dahingehend auszubauen, dass dieser Zusammenhang sich auch in der Verarbeitung rein semantischer Reize zeigt. Das heißt, dass die Verarbeitung von dargebotenen räumlichen und affektiven Wörtern so erfolgt, dass sie einen bedeutungsvollen Zusammenhang erschließen lässt.

Obwohl die vorliegenden Ergebnisse zwar ein Indiz für eine einfachgerichtete Beziehung zwischen Affekt und Raum liefern, so sind sie aber nicht ausreichend eindeutig um einen Beleg für eine automatische Aktivierung dieser metaphorischen Bedeutungszusammenhänge darzustellen. Daraus lässt sich aber nicht schließen, dass es diesen Zusammenhang nicht gibt. In der vorliegenden Diplomarbeit wird auch die Möglichkeit beleuchtet, dass die Reize direkt mit gewissen Reaktionen in Verbindung stehen, und dass diese Reiz-Reaktionskompatibilität die Ergebnisse konfundieren könnten. Zwar zeigten die dahingehenden Untersuchungen keine systematische Effekte die in eine bestimmte Richtung verfälschen könnten, dennoch könnten Reiz-Reaktions-Effekte die vorliegenden Daten zur Bedeutungsbeziehung beeinflusst haben. Des Weiteren werden andere mögliche Konfundierungseffekte erläutert, in der Hoffnung die Ergebnisse zu erklären und einen Ausblick für zukünftige Studien zu liefern.

Table of Contents

List of Tables and Figures

Tables

Figures

1. Theoretical Background and Previous Research

Why is it that we say someone is „on the *up* and *up*“, „riding *high*“, or „moving *up* the social ladder“ if they are successful, and that they are „*down* and out“ if they are desperately poor or have „hit rock *bottom*“ if life couldn't get any worse? If we are happy we feel „*elated*“, and if we are sad we feel „*down*“. People and things can be „*up*scale“ and „*high*-class“ which are usually considered desirable, or „*low*“ and „*base*“ which are negative. There are many idioms and metaphors that link positive emotions and attributes to up on the vertical axis, and negative emotions and attributes to down. The following study endeavors to shed some more light on the question of whether this link is just a figure of speech / an arbitrary linguistic relic, or whether and how these concepts may be interwoven in our mind.

1.1. Conceptual Metaphor/ Cognitive Linguistic Theories

It is a popular notion, that one of the key features that set humans apart from animals is our capacity for language, which is considered to be the culmination of our cognitive abilities. Yet, while humans are all practical users of language, and are constantly immersed in it and confronted with it, there are many aspects of language that are as yet not understood. It seems as if language is like a complicated machine that everyone progressively learns to operate since birth, until it becomes second nature, without knowing just how it works. And while humans pride themselves in how efficient and complicated this machine is, we do not know how we constructed it or even how we truly manage to operate it. Over the past centuries many scholars have attempted to understand different aspects of language, and how it is used not only to communicate about the world but also to understand it.

One of the ways people make sense of the world around them, is by using categories. Aristotle proposed that the world can be divided up into ten categories. Modern philosophers, psycholinguists and cognitive scientists tend to think that there are more, and while there is no definitive consensus on what exactly constitutes a category, they generally agree that categories are important in structuring our thoughts and ideas about things (i.e., forming concepts) (Hacking, 2001). Humans use categories to put objects and ideas in relation to another, defining them through their attributes but also through their similarities and differences to other concepts. There are two different views about how this is done.

Traditional cognitive theories suggest that language is a cognitive ability which functions in an *amodal* fashion that is independent of perception. The idea is that language is comprised of symbolic features, which derive their meanings through convention and what is attributed to them. These meanings are stored in the mind in semantic networks. Semantic networks represent the ways that humans store information, and more specifically how "words are connected to meanings and associations in long-term memory" (VandenBos, 2007, p.834). These networks are usually represented by nodes, and words/nodes that share similar meanings or are connected in a meaningful way, are also connected within the semantic network. Some words are connected more closely, and some connections are more distant or tenuous.

By contrast, modern cognitive psychologists believe that the way that people form categories is dependent on how they perceive, and in turn categories shape how they think and communicate. Modern cognitive psychologists believe that even seemingly straightforward categories such as furniture, which includes chairs that are however vastly different from tables, do not merely contain prototypical images of what constitutes a chair or a table, but also the sensations and actions that are associated with them, such as easing into a chair. They believe, that people's concept of "chair" is determined by the way that they interact with it: how it looks like to them, but also how it feels, and what they do with it (Barsalou, 2008). This is the embodied view of cognition and will be delineated in more detail in Section 1.2 below.

But how do humans categorize abstract concepts such as emotions? What information do we use to think about emotions, and to put them in relation to other concepts? Due to the ubiquitous nature of language, and because humans depend on language to adequately communicate how they think and feel, it follows that the way people talk about these abstract things, ideas and notions, is indicative of how they think about and categorize them. Therefore it seems logical that the regular co-occurrence of certain concepts within language, such as when certain types of metaphors are repeatedly enlisted to speak about abstract concepts, actually reflect how people think about and maybe even categorize these concepts. This would mean, that the frequent metaphoric link of *up* with *positive* and *down* with *negative*, which was alluded to in the introduction, suggests an inherent connection between these concepts. Indeed, proponents of the traditional amodal view of semantic networks, and advocates of the embodied view alike suggest that metaphor is an important part of how humans conceptualize and categorize.

The influential psycholinguist/cognitive scientist, Raymond Gibbs (1992), calls such thematic correspondences as mentioned above, a "systematicity of literal expressions" where "... conventional expressions cluster together under one basic metaphorical system of understanding" (p. 573). The topic of metaphors, and moreover these metaphorical systems, and how we process and use them, has been a subject of interest for quite some time and within various disciplines: philosophers, psycholinguists and cognitive scientists alike have concerned themselves with the functions and particularities of metaphors. Within the field of metaphor-research there are two major positions:

1. What McErlee and Nordlie (1999) refer to as the traditional view, which maintains that figurative language in general, and thus also metaphors, are of subordinate importance and secondary to literal interpretations. Proponents of this view also suggest language is processed in a serial fashion, which means that figurative language is only processed after a literal interpretation has failed to produce a satisfactory or sensible outcome, at which point a non-literal interpretation will be sought (cf. Glucksberg, 2003).
2. Those who like Glucksberg, Keysar, and McGlone (1992) believe that “metaphor is an important part of our conceptual system.” (p. 578) and that metaphors are thus part of how we shape and understand the world.

This second approach is the premise of the present study. Glucksberg and Keysar (1990), propose that metaphors are understood implicitly, as class-inclusions, without having to first be subject to an attempted literal interpretation and comparative processes. They suggest, that we directly understand the figurative meanings of metaphors such as “my job is a jail” because jobs are stored in the same semantic categories as jails on the grounds that they share some of the same attributes “(e.g., entities that confine one against one's will, are unpleasant, and are difficult to escape from)” (Glucksberg & Keysar, 1990, p. 3). This idea is supported by an earlier study, published by Glucksberg, Gildea, and Bookin in 1982, that refuted the conventional theory of serial processing and lent support to the notion of immediate metaphoric processing. The authors presented (a) literally true phrases (e.g., *Some tunnels are sewers*), (b) metaphors (e.g., *Some mouths are sewers*), or (c) scrambled metaphors/nonsense phrases (e.g., S*ome lamps are sewers*) to their participants who had to judge whether the presented sentences were literally true or false. Due to the fact that the participants were slower to deem the metaphors as literally false than the scrambled metaphors/nonsense phrases the authors suggested, that the metaphoric meanings were processed automatically and could not be suppressed, thus making it harder to determine that the sentence was not meaningful in a literal sense. Later, McErlee and Nordlie (1999) replicated these findings, but added another component: similarly to Glucksberg, Gildea, and Bookin one group of participants had to judge whether the phrases were literally true, but the other group had to judge whether the phrases were meaningful. McErlee and Nordlie reported, that while participants were less likely to reject the figurative word strings as literally false, compared to the nonsense word strings, there was no significant difference in the time it took to process them. This led them to suggest, that the metaphors were understood and recognized immediately as a functional metaphor, and thus more often thought to be literally true than the nonsense strings. Together with the remaining evidence they concluded that “the comparable temporal dynamics for interpreting figurative and literal strings are incompatible with any viable formulation of a serial processing model in which figurative processing is delayed until the string has been interpreted in a literal fashion. To the contrary, the data suggest that both types of interpretations were computed in equal time” (p. 491-492). However, as McErlee and Nordlie were not really testing the time it took to understand a string, but merely the time it took to judge it as meaningful or literally true, it is a bit tricky to jump to such conclusions. Particularly, when in their experiments the figurative strings were less likely to be judged meaningful, and less likely to be judged as literally false, than the literally true phrases which could be indicative of a speed-accuracy trade-off. Furthermore, McErlee and Nordlie conducted this study with merely 13 participants, who were further divided into two groups (judging meaningful, judging literally true) leaving only 6 and 7 participants per test condition. All the same, combined with other studies from the field of cognitive science (some are delineated further on), these and similar studies on metaphor-comprehension lend credit to the notion figurative language is processed directly, and that metaphors are not merely pretty linguistic features.

Gibbs (1992) attributes even more importance to metaphors, suggesting that not only are metaphors included within the categories that they refer to due to similarity, but rather that metaphors form the basis of semantic networks. He proposes that “ metaphor is a fundamental characteristic of how people categorize and make… sense of their experience” (p. 572) and that instances of metaphors in language “reflect underlying conceptualizations of experience in long-term memory that are already structured by metaphorical schemes” (p. 572), meaning that knowledge is structured in terms of metaphors. This should be particularly true for abstract concepts such as love, time and the topic of this thesis, good and bad, which are difficult to conceptualize and might well rely on metaphoric categories in order for humans to be able to think about them.

Lakoff and Johnson (1999) suggest that these metaphoric categories, are formed automatically because of the way we interact with the world, and that they help us reason about certain concepts in ways we otherwise could not. These, as they call, *conceptual metaphors* allow us to think and communicate about complex abstract notions, and many of the manifest metaphors and idioms used in language are merely instantiations of these underlying structures. This would explain the pervasive occurrence of clusters of thematically similar metaphors and idioms, which stem from one notion. An example that Lakoff and Johnson as well as various supporters of their theory have used, is the idea of *love as a journey*, which seems to be a metaphoric concept that gives rise to a multitude of related idioms and metaphors such as “star crossed lovers”, “our relationship has hit a dead end”, or “we're at a dead end” (Lakoff & Johnson, 1999, p.64). In this case the conceptual metaphor would be that life and also love is a journey, which guides how we think and consequently talk about love. Another interesting example that Lakoff and Johnson (1999) give of how this metaphoric conceptual system actually shapes how we think, is illustrated in this excerpt where metaphor guides how we think about internal struggle:

> Consider the common experience of struggling to gain control over ourselves. We not only feel this struggle with us, but conceptualize the “struggle” as being between two distinct parts of our self, each with different values. Sometimes we think of our “higher” (moral and rational) self struggling to get control over our “lower” (irrational and amoral) self.
>
> Our conception of the self, in such cases, is fundamentally metaphoric. We conceptualize ourselves as split into two distinct entities that can be at war, locked in a struggle for control over our bodily behavior (p. 13).

Lakoff and Johnson propose that these conceptual metaphors form integral parts of our cognitive systems that are learned automatically very early on in childhood. When children are very young, they cannot differentiate between subjective experiences/emotions and sensorimotor experiences. For example, mothers tend to demonstrate their affection by holding the infant who then feels loved, soothed, and comforted, but also feels the physical warmth of the mother's body, and cannot differentiate these sensations → they become *conflated*. Throughout time these automatic conflations of co-occurring subjective experiences and sensorimotor experiences are repeated and thus become solidified associations that endure even after the child becomes old enough to differentiate between these experiences, and while people may be unaware of these connections, they subsequently form the basis of metaphors such as “a warm smile” (Lakoff and Johnson, 1999, p. 46). The authors argue, that the repeated co-activation of the neural networks involved in these conflations, forge a neural connection between the internal experience and the sensorimotor experience that determines conceptual metaphor: “Whenever a domain of subjective experience or judgment is co-activated regularly with a sensorimotor domain, permanent neural connections are established via synaptic weight changes.” (Lakoff and Johnson, 1999, p. 57). In the case of the associations between *up and positive*, *and down and negative*, it is conceivable that early childhood experiences of being picked *up* to the parent's embrace, looking *up* at the loved ones, or an *up*right body posture is conflated with positive emotions, while being *low*ered away from the parent, or falling *down* and maybe even hurting oneself are conflated with negative emotions. These links form the basis of the “*up is positive*” and “*down is negative*” primary / conceptual metaphor which in turn give rise to the metaphors and idioms mentioned above. Lakoff and Johnson assert that there are a plethora of primary /conceptual metaphors, which provide an inferential framework for semantic structure, sensorimotor sensations, feelings and images.

An important distinction emphasized by Crawford (2009), however is, that this does not mean that we cannot, for example experience emotions without metaphor, but rather that metaphor guides the way we think about these emotions and how we communicate these emotions to others. Therefore we can, for example “...experience positive affect, but we cannot think about it without recruiting our concepts of space, brightness, or other physical dimensions.” (Crawford, 2009, p. 131). Furthermore, Lakoff and Johnson suggest that metaphors are mainly used to think about abstract concepts, but that it is possible to think about literal concepts without metaphors.

While Lakoff and Johnson, and other proponents of conceptual metaphor, provide interesting and very compelling ideas, they mainly rely on the observations of linguistic phenomena and anecdotal evidence to support their theory and provide little in the way of experimental evidence. By contrast, the field of cognitive science, moreover the exploration of *embodied cognition* offers strong evidence for the multimodal nature of the human mind (i.e. the integration of different sensory and motor perceptions) and verifies many of the ideas of conceptual metaphor which are important for the study at hand.

1.2. Grounded or Embodied Cognition

In their book Philosophy in the Flesh, Lakoff and Johnson (1999) do not only maintain that metaphors are an integral part of how we conceptualize and categorize the world we live in, but they also argue that metaphors and other concepts are fundamentally embodied, which means that cognitive states and bodily states are inherently linked. According to Lakoff and Johnson “it is conceivable that the same neural system engaged in perception (or in bodily movement) plays a central role in conception. That is, the very mechanisms responsible for perception, movements, and object manipulation could be responsible for conceptualization and reasoning." (p. 37-38). In other words, sensorimotor processes shape the way we think and categorize the world, and metaphoric categories are a part of this embodied conceptual system.

This embodied view focuses on how "abstract concepts are grounded metaphorically in embodied and situated knowledge" (Barsalou, 2008, p. 621) and is only one of the different theories of embodied cognition. While the existence of a uniform theory of embodied cognition is a common misconception, the general notion underlying embodied cognition is that the different modal representations (= perceptual, motor and introspective systems) work together, perhaps even with symbolic amodal (=symbolic or semantic) systems to create cognition (Barsalou, 2008, p.618). According to Barsalou's (1999) theory of *perceptual symbol systems* the brain works in a multimodal fashion, integrating cognitive processes, such as perception, motor activity, memory, and conceptual knowledge within different systems. This means that the semantic memory and sensorimotor systems all work together, and when later a part of this system is activated, the other parts are automatically activated with it, in what he calls simulations. Thus, for example in order to retrieve a memory, humans activate the associated sensorimotor representations. Depending on the cognitive processes that are necessary, these systems are activated and controlled in different fashions.

Hauk, Johnstrude, and Pulvermüller (2004) were able to demonstrate this phenomenon with an fMRI study, which showed that when participants read action words that were associated with arm-movements (e.g., *pick*) , the corresponding areas of the motor and pre-motor cortex for arm action words were activated that were also active when the participants moved a finger. When participants read action words that were associated with leg-movents (e.g., *kick*), the corresponding pre-motor and motor areas were active that were also activated when the participants moved their foot. This substantiates the assumption of embodied cognition that sensorimotor integration of the interactions between the self and our surroundings forms the representations of these surroundings, and that the entire system is activated if only a part of it is addressed. Therefore, for example, when people think about a baseball bat, not only do they form a mental picture of a bat, but also the sensorimotor systems that are responsible for feeling the texture, exerting the grip, holding and swinging the bat maybe even looking at the pitcher and hearing the teammates chant, are all activated and are a part of how they conceptualize a baseball bat. Depending on the demand of the access to this concept this system may be controlled by different areas of the brain, or perhaps activated to a different degree, but all the associated systems are activated even if only a few are necessary: “when knowledge is needed to represent a category … , multimodal representations captured during experiences with its instances are reactivated to simulate how the brain represented perception, action, and introspection associated with it” (Barsalou, 2008, p. 618-619).

This can also be extended to emotions and subjective sensations, because as Barsalou (2008) also asserts, that “...people simulate internal states similar to how they simulate external states (e.g., Havas et al. 2007, Niedenthal et al. 2005)” (p. 634), suggesting that because humans do not only experience external sensations, perceptions, and actions but also internal states and emotions that these can also be embodied. This is perhaps where metaphor theory, and specifically Lakoff and Johnson's (1999) theory that primary metaphors are learned through conflation, and embodied cognition theory share a common ground: that abstract concepts, such as emotional states, are embodied and thus linked to other concepts, sensations and actions.

The study by Havas, Glenberg, and Rinck (2007) that Barsalou (2008) refers to, was modeled after a study conducted in 1988 by Strack, Martin, and Stepper who had asked participants to either hold a pencil between their teeth, to simulate a smile, or between their lips to prevent a smile and then rate cartoons according to how funny they were. Participants who held the pencil between their teeth, thereby simulating smiling, rated the cartoons as funnier. This led Strack, Martin, and Stepper to conclude that (the evaluation of) affect was linked with the sensorimotor action of smiling in such a fashion that simulating smiling facilitated positive affect. Havas, Glenberg and Rinck (2007) used a similar procedure, only their participants had to read sentences that either had a positive or negative valence[1] and had to judge them as either (a)positive or negative or (b) either “easy” or “hard”, while holding a pencil between their teeth simulating a smile, or between their lips simulating a frown. The authors found, that participants judged the positive sentences faster in the smile conditions and the negative sentences faster in the frown conditions. Thus they confirmed the idea that positive and negative emotions are linked in an embodied fashion to smiles and frowns, so that artificially simulating the facial expressions, also simulates or facilitates the emotions that they are associated with.

It is possible that the embodied nature of smiles and frowns could also extend to the embodiment of up with positive and down with negative that is investigated in this study, because in order to smile the muscles have to pull *up* the corners of the lips creating a

[1] Valence is the subjective value of an event, object, person, or other entity. There is only positive or negative valence. (VandenBos, 2007, p. 974)

sensorimotor perception of up, and in order to frown the muscle have to pull *down* the corners of the face, creating a sensorimotor perception of down, and since positive was associated with smiling and negative with frowning, the sensorimotor perceptions could extend to these concepts in an embodied fashion. There is further evidence that suggests that the metaphoric connection between up and positive vs. down and negative, is fundamentally embodied.

1.3. Up is good, down is bad

One of the possible explanations for the metaphorical link between positive and up and negative and down, is just that embodied connection between smiling (pulling *up* of the lips) and frowning (pulling *down* of the lips) that was mentioned above. Another explanation may be, that we tend to associate an upright body-posture with positive emotions (such as confidence and pride), and a slumped body-posture with negative emotions (such as failure) (cf. Stepper & Strack, 1993). This is also manifested in the idiom "to hold your head high", which means that one shows that they are not defeated by failure but rather proud of their efforts. Also as mentioned earlier, children learn to associate *up* with the presence of their parents and being picked up and comforted and the *positive* emotions that they feel when that happens at a very early age. At the same time they learn to associate being put *down*, away from their parents, or falling down and the experience of discomfort and pain with down and the *negative* emotions they feel. Several researchers also found that power is associated with upward attention and submission and low power is associated with downward attention (cf. Giessner & Schubert, 2007; Moeller, Robinson, & Zabelina, 2008; Schubert, 2005). Furthermore, other researchers have shown that the association of God, Devinity and Heaven with up (leastways in Western cultures), and the association of the Devil and Hell with down and below, are not merely reflected in the way we talk about these concepts, but are also embodied in a metaphor-consistent way (Meier, Hauser, Robinson, Friesen, & Schjeldahl, 2007). Because people tend to think of power, God, and Heaven as positive; and weakness, Devil, and Hell as negative; the association of positive with up and negative with down could have arisen from these embodied concepts.

Regardless of the origin, a very early and interesting study that empirically demonstrated the existence of this internalized/embodied connection of positive with up and negative with down, was published back in 1957 by Wapner, Werner and Krus. To create emotional states of "success" or "failure" the authors chose students who had received a grad of *A* (which is the best grade possible) or *F* (which is the worst grade and means one failed) on a previously administered mid-term examination. The students were unaware of their grades when they were recruited, and during the first half of the experiment. The experimenters cleverly rigged the situation, so that it looked like a coincident that the professor came upon the students during a break in the experiment and happened to use that chance encounter to inform the students of their grade (a control group merely received a rest during the break). After the break the students, who were now aware of their grades, continued with the experiment, feeling either dejected if they had received news of an F (failure), or happy when they had received news of an A(success). These were the mood induced trials, and the trials which were completed before the break served as a baseline. The participants had to instruct the experimenter to move a luminous square up or down, so that the line bisecting it was at eye level. Wapner, Werner and Krus found, that participants in the success conditions tended to shift the apparent horizon upwards (mean = +15 cm) from the baseline conditions (before they found out that they had an A), and that participants in the failure conditions tended to move the apparent horizon downward (mean = -38cm) compared to their baseline. The authors concluded that “it has been shown that transient laboratory-induced feelings of success and failure affect localization in space” (p. 755).

This connection of positive and negative emotion and verticality is pervasive across the modalities. One such modality is spatial memory, as demonstrated by Crawford, Margolies, Drake, and Murphy (2006) who presented images that evoked positive or negative affect at different locations on a computer screen, and tested for the ability to recall the location of the image (p.1155). In their Experiment 1 the authors used 30 *positive* and *negative* images, and presented them at different positions in the learning phase, focusing the participants' attentions however not on the location of the pictures, but rather on how the pictures made them feel. Then in the testing phase, the participants had to move the picture from the center of the screen, to the location at which it was originally presented. Crawford et al. found that the participants showed a bias to place the positive images higher, which to the authors suggested an underlying, nonlinguistic association between *good* and *up*. In their Experiment 2, which used an immediate recall task (i.e., participants had to immediately recall the location of the picture, as opposed to the previous delayed recall that had a separate learning phase and testing phase) the authors were able to confirm the upward bias of positive stimuli, and also found a downward bias for the negative stimuli, and the *down* is *bad* association. Both, delayed and immediate spatial memory, are therefore influenced by affect in the metaphor-consistent manner.

Another modality that is subject to the association of up with positive and down with negative valence is the perception of pitch. According to embodied cognition theory (and the theory of primary metaphor) internal sensations, feelings, perceptions and actions are integrated when they occur simultaneously. Thus, just as an upright posture and upturned corners of the lips facilitate the positive emotions with which they are associated, and a slumped posture downturned corners of the mouth facilitate the negative emotions with which they are associated, so too does *high* pitch activate positive emotions, and *low* pitch activate negative emotions. This relation between pitch and emotion is underlined by "converging evidence from different disciplines within and outside psychology [which] shows that the distinction between relatively high versus low tones is connected to signals of friendliness and happiness, versus to signals of threat and anger" (Horstmann & Ansorge, 2011, p. 975). This makes sense, considering that, for example babies, who are dependent on their mothers love, affection and instinct to protect them, have a high pitch which might help precipitate the mother's instinctive responses. Horstmann and Ansorge (2011) showed how emotions, space and pitch are all connected in "an intermodal associative triangle" (p. 975). In their study, participants were required to (a) imitate a happy or an angry facial expression that was presented on a screen, (b) tilt their heads upwards or downwards in the same fashion as the person on the screen or (c) in the control condition tilt their head left or right in the same fashion as the person on the screen; while high or low pitched tones were presented simultaneously in a random fashion. This experiment revealed a significant interaction between pitch and facial expression, and between pitch and head movement such that "with a high tone, happiness was imitated faster than anger, whereas with a low tone, anger was imitated faster than happiness. Furthermore, with a high tone, an upward head movement was faster than the downward head movement, whereas with a low tone a downward movement was faster than the upward movement" (Horstmann & Ansorge, 2011, p. 977-978). This validated their assertion that pitch, spatial verticality, and emotions are linked in an embodied fashion that is consistent with previously found associations of positive with up and negative with down, and positive with high pitch and negative with low pitch.

As mentioned above, the different modalities work together for humans to understand and represent language. Rather than merely depending on the instantiations of clusters of systematically similar metaphors, and other figurative language, as proof for the underlying semantic link between up and positive, and down and negative; Meier and Robinson (2004) directly tested the influence of words with affective meaning on vertical spatial processing, and the influence of the vertical spatial presentation on affective word processing. The authors found that when participants had to evaluate words as positive (e.g., *hero*) or negative (e.g., *liar*) that were positioned on different vertical locations on the computer screen, they evaluated positive words that were presented on the top of the screen faster than when they were presented on the bottom, and negative words faster when they were presented on the bottom of the screen than when they were presented on the top. They also found that when these words with positive connotations were presented at the center of the screen, participants were better able to identify a letter that was presented at the top of the screen, and when a word with negative connotation was presented at the center of the screen, they were better able to identify a letter that was presented at the bottom. However, when participants had to say whether a spatial cue was presented at the top or the bottom of the screen by saying “up” or “down”, there was no significant link with their speed to subsequently identify words as positive or negative. This led Meier and Robinson to conclude that affective words biased and promoted spatial attention in a metaphor-congruent fashion, while this metaphor was not reversible to the extent that the spatial cues promote processing of metaphor-congruent affective words. In a later study Meier and Robinson (2006) also found that depressed and highly neurotic individuals had a downward attention bias and that downward attention generally correlated with negative affect. Together these findings underscored the metaphoric relationship of positive with up, and negative with down, and inspired the study at hand.

There are, however, three main problems in Meier and Robinson's (2004, 2006) studies that the present thesis attempts to address. In their experiments the authors mixed the modes of representation, requiring semantic processing of the valence words, but direct visual spatial processing of the positions at which the stimuli were presented on the screens. By contrast, the present study endeavored to keep the processing modality consistent, and therefore both the affective as well as the spatial components were tested with words that were presented at the center of the screen. Furthermore, Meier and Robinson used words that had previously been determined to have certain positive and negative affective qualities for the affective stimuli for their studies, but Havas et al. (2007) contest that affective words may be context dependent and do not necessarily stimulate the according emotions on their own, as opposed to words that directly name emotions. Therefore, the present study used positive and negative valence words. Lastly, Meier and Robinson presented all the stimuli in a clearly visible fashion for relatively long durations. This makes it difficult to sustain their claim that their experiments “provide evidence for an automatic association between affect and vertical position” (Meier and Robinson, 2004, p. 247). In order to truly test for this asserted *automatic* association between affect and verticality, which would suggest that the link is fundamentally embodied, a *masked semantic priming* paradigm was used in the present study, as is detailed below.

1.4. Masked Semantic Priming

When investigating the human mind and the way we receive, process, and store information we are frequently faced with the black box conundrum. Meaning, that oftentimes we have a concept of what stimuli we react to, and we can determine to a certain degree how we react to them, but we lack detailed knowledge of the mental processes involved. Over the past years and decades brain-imaging techniques such as functional Magnetic Resonance Imaging (fMRIs) and Positron Emission Tomography (PET) , and other physiological measures such as Electroencephalography (EEG) have provided means to shed some light unto these fundamental questions of cognitive processes. In addition to using such physiological methods, scientists in the field of cognitive psychology employ a plethora of experimental methods and designs to deduce how information may be processed, stored and retrieved.

One such experimental method to investigate cognitive linguistic processes is semantic priming, which allows for indirect inferences about cognitive networks, as well as semantic relationships and lexical processing. In priming tasks, two stimuli are presented sequentially, the first is the prime stimulus and the latter is the target stimulus, to which the participants have to respond by performing a task. The prime stimulus is usually related to the target (prime and target share a common feature), or unrelated to the target (prime and target differ in regards to the relevant feature). This degree of relation, or similarity, between prime and target can be based on perceptual features (e.g., prime and target consist of much of the same letters, or both prime and target are objects that point in the same or different directions). Or the similarity can be based on conceptual features, in which case the stimuli would be related (e.g.,an *upward pointing arrow* and the word "*north*", a *high sound pitch* and the word "*high*", or the words "*mammal*" and "*cat*") or unrelated (e.g., a *downward pointing arrow* and the word "*north*" *, a high sound pitch and the word "low"*, or the words *"furniture"* and *"cat"*) based on meaning and relevance, but would not necessarily share common perceptual features. Semantic priming refers to the effect that the processing of targets is more efficient when the preceding primes are conceptually/meaningfully related (henceforth termed *congruent*) than when they are conceptually/meaningfully unrelated (henceforth termed *incongruent*). (cf. Rossell, Price, & Nobre, 2003; Van den Bussche, Van den Noortgate, & Reynvoet, 2009). This distinction between related and unrelated could be considered a little simplistic, since opposition or distinction may also be an integral part of understanding. Concepts are also put in relation to one another by their differences and defined in part by what they are not, not merely by what they are. Furthermore, some authors distinguish direct relation and indirect relation, and some also consider words that frequently co-occur as semantically related. Therefore, whether primes and targets are related, and moreover the distinction between "congruent" and "incongruent" prime-target pairings, becomes a somewhat subjective framework (premise), a problem which authors sometimes try to circumvent by either conducting preliminary investigations, or relying on established inventory or norms. (See also Klauer, Eder, Greenwald, & Abrams, 2007; and category congruency priming below).

The influence that the primes have on the processing of the targets is measured by the time it takes for the participants to respond to the targets (called *reaction times*), and the accuracy of the responses (usually expressed as an *error-rate*), under the different prime-target conditions. Faster and more accurate responses to congruent primes-targets could indicate an underlying connection and an activation of this connection so that the prime subsequently facilitates the processing of the target. This is the so called "*...semantic priming effect* [which] refers to the consistent observation that people respond faster to a target word (e.g., *cat*) when it is preceded by a semantically related prime (e.g., *dog*) rather than by an unrelated prime (e.g., *table*)." (Hutchison, 2003, p. 786). Therefore faster reaction times indicate semantic relation (cf. Brunel & Lavigne, 2008).

Semantic priming paradigms also allow for different tasks that the participants have to perform in response to the targets. Participants are frequently required to perform *lexical decision tasks*, where they have to determine whether the target is a word or nonword (a string of letters that is not a real word). In a *naming task* the participants are required to name the target aloud. In the present study, participants were asked to perform a *semantic categorization task*, in which they were asked to determine whether the target belongs to one category or another (in this case whether the target is an affective/emotion word or a spatial word), and thus access to semantic information becomes a prerequisite to perform this task. (cf. Rossell, Price, & Nobre, 2003; Van den Bussche, Van den Noortgate, & Reynvoet, 2009).

The fact that language is rife with layers of meanings, metaphors and personal connotations, is not merely part of the subject of this thesis; As it is an ubiquitous phenomenon, it also affects the body of this thesis, because it too communicates through language. This becomes particularly apparent when it comes to detailing the method used to ensure automatic processing. In order to ascertain that the metaphoric connection between affect and verticality is implicit and accessed automatically, the primes were presented *subliminally*. For laypersons this word, however, conjures up unnerving associations of easy manipulations and powerful unconscious suggestions to consume this or think that, through unseen advertisement or media. These notions stem from informations which were falsely disseminated in the 1950s and quickly made their way into popular culture. However, contrary to these bogus reports of covert manipulations through images or texts embedded in consumer media, priming with subliminal stimuli has been a well-established method of choice. In subliminal priming, the primes are "...presented below the 'limen' or threshold for conscious perception" (Kouider & Dehaene, 2007, p.857) so that the participant isn't aware of them or their content. This is usually accomplished through short durations of presentation of the primes and through *masking*, which is a method where a stimulus that is designed to interfere with the conscious processing /recognition of the prime is presented either before, after, or before and after the prime. "Subliminal perception is inferred when a stimulus is demonstrated to be invisible while still influencing thoughts, feelings, actions, learning or memory." (Kouider & Dehaene, 2007, p.857).

One of the most influential studies that proposed that not only basic levels of processing such as reflexes are automatic, but that also semantic processes can occur without conscious awareness, used masked semantic priming as a method and was published by Marcel in 1983. In his experiments Marcel mainly used backwards pattern masks, consisting of (a) mask fields of parts of letters and (b) letters in random orientations; that were presented after the prime (or a blank card) and before the target. Not only was he able to show that, contrary to energy masking, backward pattern masking "interferes with phenomenal representation, or at least subjective confidence in phenomenal presentation, while not affecting the automatic pattern analysis of the masked stimulus." (Marcel, 1983, p. 223), but that "...a word which is backward pattern masked such that it is not only unreportable but also undetectable, nevertheless gains access to a lexical or semantic representation." (p.218). In his Experiment 1, where participants had to (a) judge whether a prime was present, (b) whether the prime and target were graphically similar, or (c) whether prime and target were semantically similar, Marcel found that as the word-mask stimulus onset asynchrony (SOA[2]) was reduced, participants could no longer make detection judgments (say whether the prime was present), then failed in graphic similarity judgments, and the most robust judgment, was that of semantic similarity. Therefore, Marcel came to the conclusion that "...semantic information was available when visual information was not" (Marcel, 1983, p.206). Based on his findings, Marcel suggested that, contrary to previous theories that had assumed that perceptual processing occurs in discernible hierarchical stages, of which unconscious

[2] The prime-target SOA refers to the time elapsed between the presentation of the prime and presentation of the target

processing is merely a small inferior sliver, "...an enormous amount of visual processing is necessarily carried out automatically and without awareness" (Marcel, 1983, p. 199), and that semantic processing may well be one of these cognitive processes that occur, in part, without conscious awareness. However, as Marcel himself also concedes, in his study the degree of prime-visibility was determined in a subjective fashion that relied on self-report, and might not necessarily indicate that the primes were truly not visible. He proposes that direct measures of prime-visibility, which look at how the processing of the prime effects the processing of another stimulus, should be used instead, as they were in the present study.

While Marcel's experiments (1983), have since been subject to criticism, the implications of these findings are profound and have been the basis for many studies since, of which this is one. Before detailing these later findings, it would be interesting to look into some of the criticisms offered by Holender and Duscherer (2004), since they address some crucial points that have been taken into consideration for the present experiment and its analysis. For one, Holender and Duscherer argue that it is important to differentiate between a semantic priming effect and what they call a *congruency effect* (but is commonly referred to as a *response-compatibility effect*). Holender and Duscherer took issue with the fact that in congruent conditions the prime and the target would activate the same response, whereas in incongruent conditions the prime would activate a different response than the target. Thus, the effects that Marcel interprets as semantic priming effects, could actually be due to response-compatibility effects, such that the primes pre-activate and don't interfere with the response in the congruent conditions and interfere with the responses in the incongruent conditions (Holender & Duscherer, 2004, p. 873). This distinction is an important one, because it makes a vast difference whether the effects are automatic stimulus-response mappings or whether they are semantic priming effects that are indicative of semantic and cognitive relations. Response-compatibility effects and their potential implications for the present experiment are detailed below in the response-mapping section.

Another important assertion made by Holender and Duscherer (2004) is that particularly modern methods do not suffice to truly mask stimuli to a degree that they are not consciously accessible, using only backwards masking. They maintain that, particularly refresh rates of computer screens and "use of the available typographical characters as masks (e.g., &&&&&, %#%#%, DsbuQV)..." (p. 873) are limitations that allow for conscious identification or at least for in part conscious awareness of the primes, regardless how short prime exposure is. However, Holender and Duscherer suggest that sandwich masking (where the prime is sandwiched between two masks: the forward mask is presented before the prime, and the backward mask is presented after the prime) is a sound alternative to ensure subliminal priming. In order to ensure that the primes are sufficiently masked in the present study, they were sandwich masked in accordance to the methods that were shown to be effective in previous studies (Kiefer & Brendel, 2006; Lupker & Davis, 2009).

In a controversial study published in 1998, Dehaene et al. expanded on Marcel's (1983) finding that judgments of semantic similarity can be part of automatic processing, by demonstrating that semantic categorization can also occur automatically and that these automatic processes coincide with observable brain activities. The authors presented numerals from 1 to 9 as primes and targets, the primes were sandwich masked with nonsense letter strings, so that the participants weren't aware of them. The participants had to determine whether the target was smaller or greater than 5 through left or right keypresses. Not only were Dehaene et al. able to show, that reaction times were faster when primes and targets were congruent (i.e., both primes and targets were either smaller or greater than 5) than when they were incongruent (i.e., the prime and target were on the opposing sides of 5), but they also used event-related potentials (ERP) and functional magnetic resonance imaging (fMRI) to show, that the covert primes elicit lateralized motor activation, preparing the response that would be category conform to the prime. This leads to response-competition and delayed motor responses in incongruent conditions where the target requires a different response from the one which was pre-activated by the prime. Based on their findings, which combined behavioral responses and brain imaging techniques, the authors came to the conclusion that semantic activation truly occurs automatically, in an embodied fashion, and that “...the prime must have been categorized at the semantic level” (Dehaene et al. 1998, p. 599).

Later, Damian (2001) criticized Dehaene et al. (1998), suggesting that the limited number of primes and targets, and the fact that the primes were used as targets and vice versa, could have resulted in learning effects within the experiment and in stimulus-response mappings that are not indicative of semantic categorization, but rather bypass them and activate motor responses directly due to practice. However, many more recent studies since then have managed to lend credit to the findings of both Marcel (1983) and Dehaene (1998). Markus Kiefer (2002), for example, used the N400 component, which is an ERP measure that is strongly associated with semantic processing, to show that “...unconsciously perceived prime words facilitated responses to a subsequently presented, semantically related target word...” (p. 36), both on a behavioral level, as well as on a phenomenological level as shown by the N400 ERPs, even when primes are sandwich masked and the stimulus onset asynchrony (SOA) between prime and target is very short (67ms). Abrams, Klinger, and

Greenwald (2002) argue, that any priming effects are amplified due to practice by using primes that were once visible either as targets, or as unmasked primes, are not due to stimulus-response mappings, but rather due to stimulus-category mappings, that are either learned or reinforced in practice. If this were true, then semantic categorization does take place automatically, but it is not necessarily reflective of already established networks, but can be artificially created within the experimental setup, or pre-existing classifications can be reinforced. Klauer, Eder, Greenwald, and Abrams (2007), also used a masked semantic priming paradigm, with sandwich masking, and their participants had to perform a valence-classification task, in which they had to categorize the target word as either positive or negative. The authors found that also novel primes with little or next to no feature-overlap with the targets, cause congruence effects between positive primes/targets and negative primes/targets. Klauer et al. (2007) also make a distinction between semantic priming and category congruency priming, asserting that in category congruency priming "both congruent and incongruent prime-target pairs are categorically related: Congruent primes and targets share the same category membership (e.g., the category of positive words), incongruent primes and targets are members in semantically opposite categories (e.g., the target is a member of the set of positive words, whereas the prime is a member of the set of negative words)." (p.64). Not only were Klauer et al. able to show category congruence effects for novel primes, but they also showed, that abstract concepts such as valence can be considered a category and that words can be subject to automatic semantic processing /categorization according to valence. (For more information on category congruence see also Quinn & Kinoshita, 2008). Similarly, Ansorge, Kiefer, Khalid, Grassl, and König (2010) found congruence effects, based on short-term and long-term representations, between spatial words that denote the vertical dimension *up* and *down.*

In the present study, stimuli were also *positive* and *negative* valence words, as well as vertical spatial words that either refer to the spatial dimension *up* or the spatial dimension *down*. Both valence words and spatial words were used as primes and targets. All prime-target pairs were category incongruent, meaning that when primes were valence words the targets were spatial words, and when the primes were spatial words, the targets were valence words. For the purposes of this experiment congruence is therefore defined in line with the assumed semantic connection of the spatial dimension *up* with *positive* valence, and the spatial dimension *down* with *negative* valence, and to avoid confusion this congruence is termed metaphor-congruence. However, in order to prevent a category learning effect within the experiment as mentioned above (cf. Abrams, Klinger, & Greenwald, 2002), participants had to perform a semantic categorization task on the target that ignored the dimensional attribute of the target (positive/negative or up/down became irrelevant): they had to determine whether the target was a “valence word”, or a “spatial word” through left or right keypresses. Responses were evaluated according to their response times and error-rates. Since primes and targets were always category incongruent, if metaphor-congruent prime-targets were to be responded to faster and more accurately, then it would not be due to category congruence as suggested by Klauer et al. (2007), but rather due to a semantic priming effect that is indicative of a cognitive link between up / positive and down / negative. In order to test whether this priming effect was automatic, the primes were presented in two conditions: subliminally in a sandwich masked fashion, with random letter masking and a stimulus onset asynchrony of 68ms between prime and target (as suggested by Kiefer & Brendel, 2006; and Lupker & Davis, 2009), to be compared with the aware conditions where primes were presented in an unmasked fashion with blank screens instead of the masks and the same SOA of 68ms. Visibility was tested directly for the masked and unmasked conditions, in visibility blocks with additional tasks, to verify that participants were not consciously aware of the primes in the masked conditions, and were able to see the primes in the unmasked conditions (cf. Khalid, König, & Ansorge, 2011). Furthermore, in order to control for stimulus-response effects, left and right keypress responses for the categorization task of valence and spatial targets were counterbalanced across participants.

The present study endeavors to expand on these previous studies that have shown that positive is associated with up and negative is associated with down. Furthermore, if the experiment were to reveal metaphor congruence effects with masked primes, then that would be indicative of an automatic association of the two concepts. This would support the idea implicit automatic understanding of metaphoric context, and allow for an explanation according to conceptual metaphor and embodied cognition. In an effort to control for all other effects not only was the category learning effect minimized by the procedure, but also the stimulus-response effects were recorded. These are explained and analyzed in Section 5 further on.

2. Method

2.1. Participants

Thirty-eight participants (5 males, 33 females) successfully completed the experiment, mostly psychology students who participated in order to complete lab hours required in their curriculum. The other participants were friends and colleagues who were university students or had recently graduated university. Participants were aware of the requirements of the experiment, and signed a waiver asserting their compliance and permission to use resulting data. Eight participants had to be excluded from further data analysis because they either performed above threshold (performance over 80% correct judgments) in the visibility tests of the masked primes, or below threshold (performance at or below chance) in the visibility test of the unmasked condition (for more information on the visibility test see Section 3.1 below). All participants were native German speakers, and reported either normal visual acuity or wore their prescribed glasses or contact lenses to warrant corrected-to-normal visual acuity. The participants were aged 19-37 years; the mean age was 23 years. Three of the participants were left-handed (two of which were excluded due to their performance on the visibility tests), all other participants were right-handed. The one remaining left-handed participant met the criteria for inclusion in the data evaluation for metaphor-congruence, but was excluded for analysis of the orthogonal response-mapping as will be explained in the according section further on.

2.2. Materials and Apparatus

The participants were tested at a computer-laboratory (TR-K6) in the Institute of Psychology at the University of Vienna, Austria. Testing took place in the months of June-July 2011. The room was quiet and dimly lit, and the windows were closed and darkened, in order to prevent any distractions or glare. The stimuli were presented on a 19-inch color LCD monitor with a refresh rate of 60 Hz, and participants were required to rest their chin on a chin-rest and their forehead against an attached loop in order to provide a straight gaze and a constant viewing distance of 57 cm throughout the entire experiment. All instructions and stimuli were presented in black font (<1cd/m^2) on gray background (24cd/m^2) in 14 point Arial font at screen center. Responses were recorded using a standard German QWERTZ-keyboard, and participants had to press the letter „a“ with their left index-finger for “left” responses, and the letter „l“ with their right index-finger for “right” responses; the letters were marked on the keyboard. (See Figure 1 below for the experimental setup). Participants pressed the space-bar to proceed from instruction screens to trial screens, and to proceed after breaks. The program MATLAB was used to control presentations and record the data.

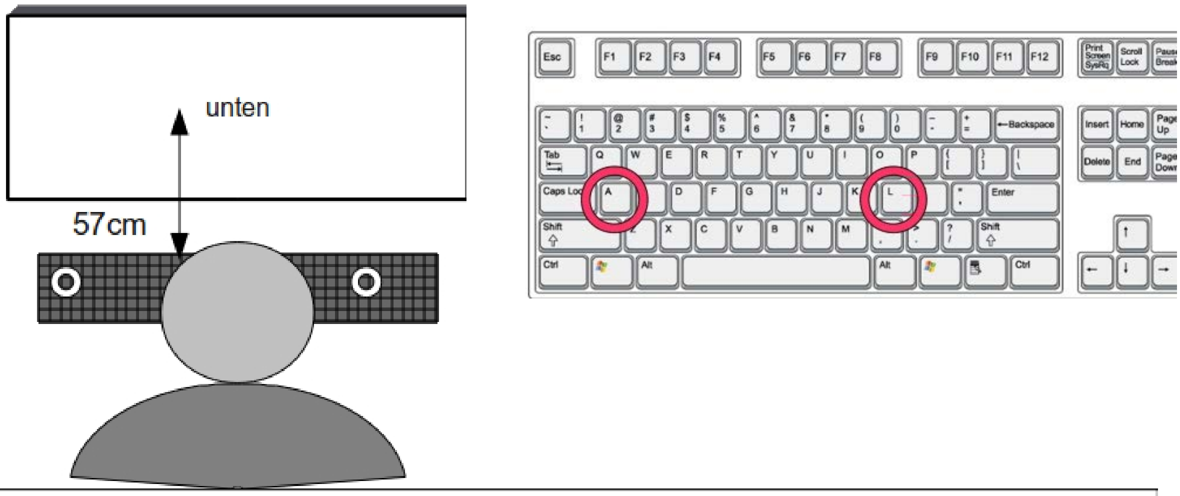

Figure 1. Schematic representation of the experimental setup (not to scale). Participants were seated in front of the computer screen, a chin-rest ensured a straight gazing distance of 57cm to the computer screen. Instructions and stimuli were presented on the screen. Participants had to respond by using their left and right index finger to press either the left key (a) or the right key (l), here circled in red for emphasis on the keyboard image to the right*

2.3. List construction

The stimuli consisted of four sets of German words. Two sets of words were the valence category words, and consisted of: (1) ten positive valence words (e.g., „lustig“ = funny), and (2) ten negative valence words (e.g., „furchtsam“ = fearful). The other two sets were the spatial category words, pertained to the vertical spatial axis, and consisted of (3) the “up-words”: ten words that refer to the upward spatial dimension (e.g., „steigend“ = rising), and (4) the “down-words”: ten words that refer to the downward spatial dimension (e.g., „abwärts“ = downward). The spatial stimuli were adopted from Ansorge, Fuchs, Khalid, and Kunde (2011). (See Table 1 bellow for complete list).

All 40 words were used randomly as primes, and the corresponding targets were chosen randomly from the 20 words of the category set that the prime does not belong to, so that each prime-target-pair consisted of a spatial word and a valence word. Therefore, all prime-target pairs were category-incongruent. The spatial words could be primes or targets and the valence words could be primes or targets, which also tested Meier and Robinson's (2004) assertion that the metaphoric effect is not reversible (e.g. *good* would prime *up*, but *up* would not prime *good*) and would also eliminate some of the learning effects which Damian (2001) criticized . This resulted in eight different possibilities of prime-target-pairings which were all evenly distributed within the experiment: (1) positive prime – up target, (2) positive prime – down target, (3) negative prime – down target, (4) negative prime – up target, (5) up prime – positive target, (6) up prime – negative target, (7) down prime – negative target, and (8) down prime – positive target. While all prime-target pairs are categorically incongruent, the stimuli are also metaphorically linked, as mentioned earlier, so that up is connected with positive, and down with negative, and this is henceforth called metaphor-congruence. Half the trials (conditions 1, 3, 5, and 7) were metaphor-congruent in this fashion, and half the trials (conditions 2,4,6, and 8) were metaphor-incongruent. All stimuli were presented in lowercase.

Table 1

List of stimulus words used as primes and targets

Valence Words		Spatial Words	
Positive	**Negative**	**Up**	**Down**
lustig (funny)	furchtsam (fearful)	steigend (rising)	sinkend (dropping)
gluecklich (happy)	aengstlich (timorous)	gehoben (raised)	gesenkt (lowered)
freudig (glad)	bekuemmert (distressed)	darueber (above)	tief (deep/low)
vergnuegt (cheery)	traurig (sad)	erhoeht (elevated)	niedrig (low)
spassig (funny)	zornig (angry)	empor (upwards)	darunter (below)
mutig (brave)	hasserfuellt (hateful)	aufsteigend (ascending)	abwaerts (downwards)
stolz (proud)	wuetend (enraged)	hoch (lofty)	hinab (down)
verliebt (in love)	frustriert (frustrated)	aufwaerts (upwards)	herab (down)
froehlich (jolly)	beschaemt (ashamed)	oben (up)	abfallend (falling off)
froh (merry)	schuldig (guilty)	hinauf(upwards)	unten (at the bottom)

Note. Columns with matching backgrounds denote metaphor-congruence. White: positive words are metaphor-congruent with up words. Gray: negative words are metaphor-congruent with down words.

2.4. Procedure

The experiment consisted of four blocks, two blocks tested the semantic priming effect of the metaphor-congruent and metaphor-incongruent primes and targets, in one block the primes were presented subliminally in a sandwich masked fashion, in the other block the primes were not masked so that the participants were aware of them. In order to eliminate possible confounding effects due to order, half the participants first completed the blocks testing with masked primes and then the blocks testing with unmasked primes, the other half completed the blocks in the reverse order. Since this is a study investigating the metaphoric link between up and positive, and down and negative, and how it extends to automatic processing of subliminally presented primes, it was imperative to verify that the participants truly were not consciously aware of the primes when they were masked, as opposed to when they were not. To this end, the visibility of the primes was tested directly with two separate “visibility blocks”, during which the participants were also required to perform a judgment task that involved the prime, in accordance to Khalid, König, and Ansorge (2011), in addition to the categorization task. The visibility block for the masked primes directly followed the block testing the metaphor-congruence effect for masked primes, and the visibility block for unmasked (visible) primes was tested directly following the block testing the metaphor-congruence effect for unmasked (visible) primes. This way the order of the visibility tests varied evenly together with the order of the metaphor-congruence effect tests and block that tested for the metaphor-congruence effect was immediately followed by a block that tested the prime visibility in that condition. (See figure 2 below).

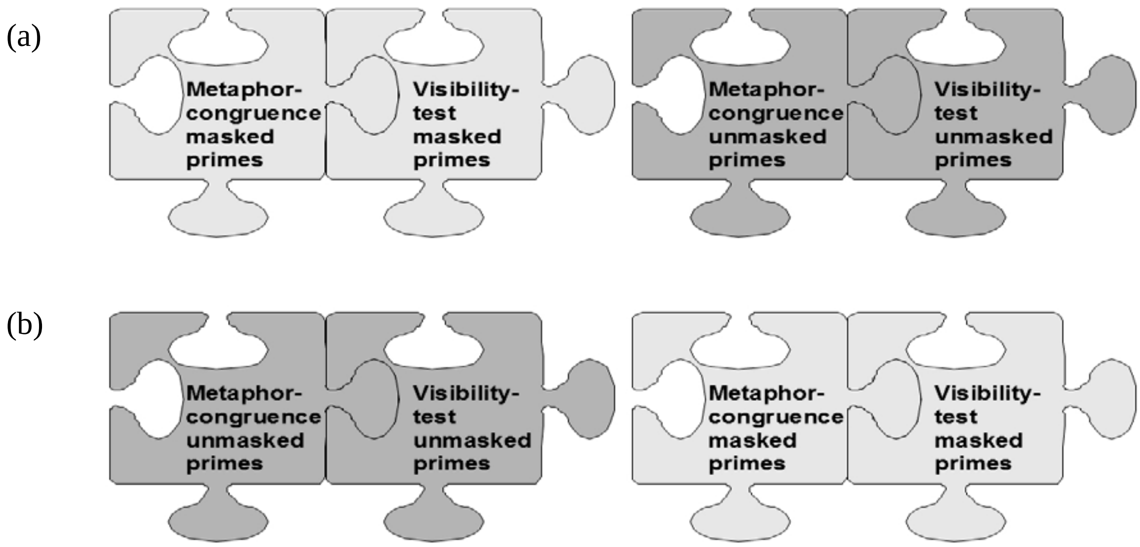

Figure 2. Schematic representation of the two block orders. Half the participants performed the blocks in order *a*, half the participants performed in order *b*.

Each block was prefaced with according on-screen instructions and consisted of 20 practice trials followed by 60 test trials. This resulted in a total of 80 practice trials and 240 measured test trials, which took an average of about 80 minutes to complete. The reaction time (RT), which is the amount of time it took the participant to respond to the target or the visibility-task, and the accuracy with which the participant responded was recorded for each of the 240 test trials.

In the masked conditions sandwich masking was used to render the primes „invisible“(cf. Khalid et al. 2011; Kiefer, 2002; Kiefer & Brendel, 2006). Each trial began with a fixation cross which was presented at the center of the screen for 750 ms, followed by the forward mask, which consisted of 10 random uppercase letters and was presented for 200 ms. Then the prime was presented in lowercase for 34 ms, followed by the backward mask, again 10 random uppercase letters, for 34ms. Next the target was presented for 200 ms, followed by a blank screen and the participants had to perform the semantic categorization task of identifying the target as either a spatial or valence word. The procedure was the same for the unmasked conditions, with the important difference that no masks were presented, instead of the masks a blank screen was presented in order to keep the same stimulus onset asynschrony (SOA) between prime and target. This sequence and SOA of 68ms is adapted from the studies published by Ansorge, Kiefer, Khalid, Grassl and König (2010); Kiefer and Brendel (2006), who showed that unconscious processing occurs at these SOAs with sandwich masking. At the same time a short SOA, such as 68ms, also prevents confounding phenomena such as inhibition of return, from occurring. (See Figures 3 and 4)

In the blocks that tested for metaphor congruence, participants were asked to categorize the targets as either being a valence word or a spatial word and to respond accordingly by pressing the left or right key. In order to test for the stimulus-response-compatibility effect (see stimulus response mapping further on), half the participants were assigned to respond left for valence targets, and right for spatial targets, and the other half were assigned to respond left for spatial targets and right for valence targets. If the participant pressed the wrong button they received feedback on the screen (“Falsche Taste” = false key). This motivated participants to respond correctly, ensured that they understood the instructions, and corrected potential inadvertent shifting of the fingers from the correct response keys. The participants were also encouraged to respond as rapidly as possible, and when it took them longer than 1.25 seconds to respond, then a prompt was displayed on the screen to work faster (“Schneller reagieren”). These feedbacks were designed to ensure that the participants responded as correctly and rapidly as possible, so that the recorded error-rates (ERs) and reaction times (RTs), were accurate measures to assess performance.

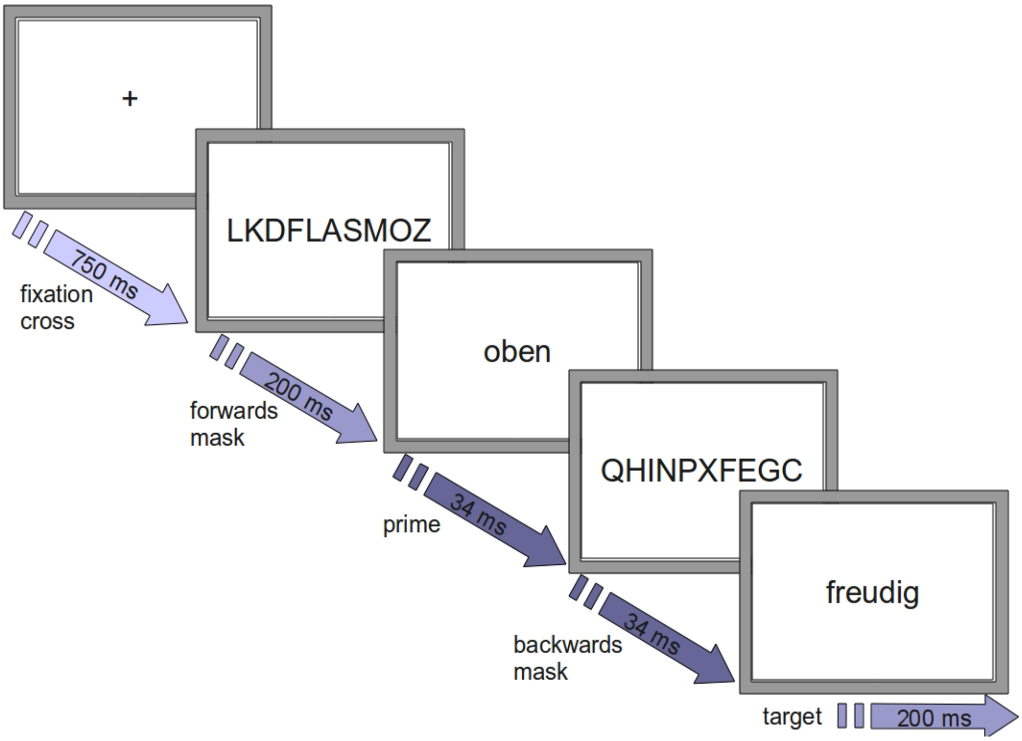

Figure 3. A Schematic representation of the experimental screen sequence for a masked metaphor-congruent condition (not to scale). The arrows denote transition from one screen to another, the time of duration for each screen is presented within the arrow below. The screen sequence presents an example of up spatial prime / positive valence target.

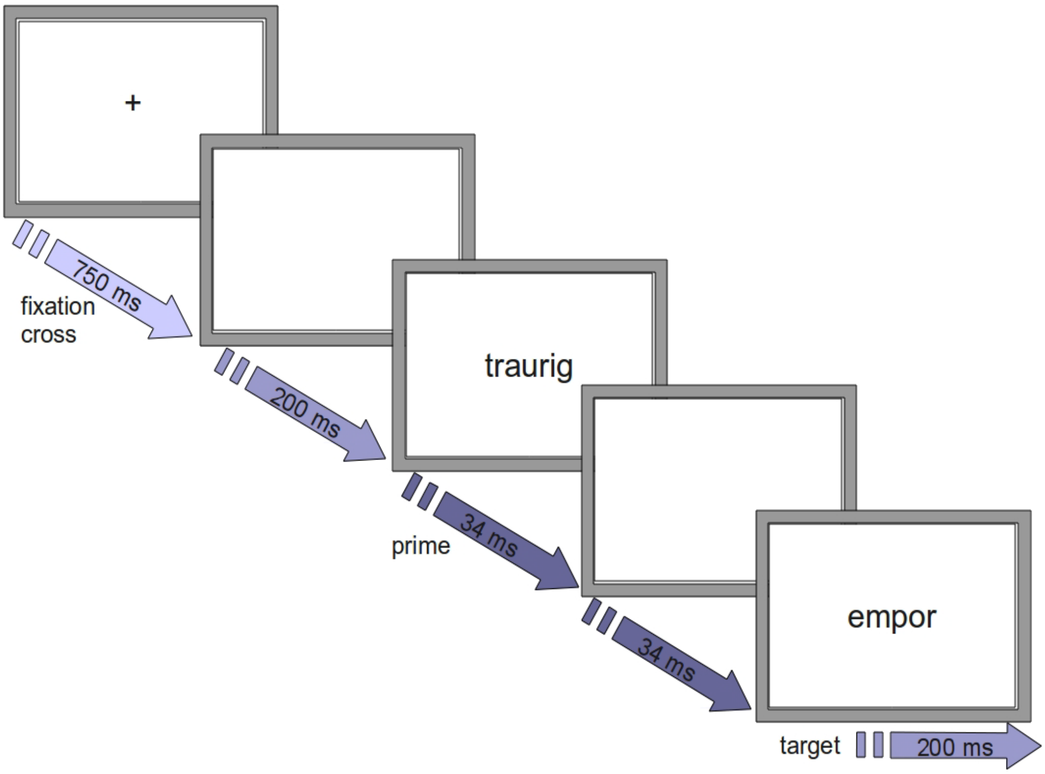

Figure 4 . A schematic representation of the experimental screen sequence for an unmasked metaphor-incongruent condition (not to scale). The arrows denote transition from one screen to another, the time of duration for each screen is presented within the arrow below. The screen sequence presents an example of a negative valence prime with an up spatial target.

The task within the visibility blocks consisted of two parts. First the participants had to perform the same categorization task as in the congruence-effect blocks. Then, in a further step, the participants were required to make a judgment as to whether the prime was metaphor-congruent with the target, or whether prime and target were metaphor-incongruent. The instructions as to what constitutes metaphor-congruence were given at the beginning of each visibility block. In order to prevent response-mapping, and to make sure that the participants were fully attentive for each task, the key-assignment designating congruence or incongruence varied randomly and evenly between left and right; the current assignment was detailed on the screen for each trial. If participants were to perform significantly above chance in the masked conditions, then the primes would not be able to qualify as being masked sufficiently enough and therefore could not be considered to be processed subliminally.

3. Results

The data were analyzed with SPSS. Effects are considered to be significant at a significance level of $\alpha = 0.05$, that is when p-values were such that $p < .05$. However effects that were even significant at stricter levels were reported as such in order to highlight them.

3.1. Visibility Tests

The visibility tests were analyzed in accordance to signal detection theory, determining the sensitivity index *d'* using hit rates and false alarms. In psychology signal detection theory is commonly used to compute a person's ability to discriminate. In the basic form the participant has to determine whether a signal is present or not. This results in two conditions: (1) presence of the signal, and (2) absence of the signal, commonly referred to as “noise”. Signal detection theory can be used, to see how well the participant can discriminate between these two conditions. If the signal is present, and the participant correctly identifies it as such, it is considered a “hit”. However, if the signal is absent (“noise” condition) and the person falsely identifies it as present, it is considered a “false alarm”. The individual participant's ability to respond correctly can be ascertained using his/her hit rate (probability of responding correctly in signal trials) and his/her false-alarm rate (probability of responding incorrectly in noise trials). The participant's ability to correctly discriminate is then determined by calculating the degree of overlap between the signal distribution and the noise distribution, using the participant's difference between his/her z-transformed hit rate and z-transformed false-alarm rate, resulting in individual *d'* scores. (cf. Khalid, König, & Ansorge, 2011;

Reingold & Merikle, 1988; Stanislaw & Todorov, 1999).

For the present study signal detection theory was used to determine the visibility of the primes, by checking whether participants were able to correctly discriminate between metaphor-congruent conditions and metaphor-incongruent conditions. The reasoning being, that in order for participants to successfully distinguish both conditions they would have to be able to see the primes, or at least be consciously aware of them. For this analysis metaphor-congruent trials were treated as signals, and metaphor-incongruent trials were treated as noise. Correspondingly, correct identification of metaphor-congruence was a hit, and metaphor-incongruent trials who were falsely identified as congruent, were the false-alarms. These were then analyzed with 4 one-sample T-tests, one for each condition: masked valence primes, masked spatial primes, unmasked valence primes, unmasked spatial primes. If the average of the participants *d'* scores in a condition did not significantly vary from zero, it means that the responses did not significantly differ from chance performance for that condition, suggesting that the participants weren't able to see the prime and merely guessed at prime-target metaphor-congruence. Using signal detection theory in this fashion provides a direct account of the participants' ability to see the primes, which is preferable to the frequently biased method of relying on the participants' self-reports of whether they saw the prime or not (cf. Khalid, König, & Ansorge, 2011). As mentioned earlier, eight participants were excluded from all subsequent analyses because of their results in the visibility tests: they either performed above threshold (performance over 80% correct judgments), indicating they tended to see the primes in the masked conditions, or below threshold (performance at or below chance) in the unmasked condition, indicating perhaps a lack of motivation, or misunderstanding of the instruction.

As predicted, for the remaining 30 participants, visibility did not significantly vary from zero in the masked conditions. For the masked valence primes the average *d'* was 0.13, $t(29) = 1.51$, $p = .14$, ($SD = 0.46$) and for masked spatial primes the average *d'* was 0.07, $t(29) = 0.97$, $p = .34$, ($SD = 0.40$). This means, that the participants were not able to successfully or reliably determine whether the prime and target where metaphor-congruent in the masked conditions, suggesting that they truly weren't able to see the primes and merely guessed at congruence. By contrast, in the unmasked (visible) conditions the results indicate that the primes were visible. For unmasked valence primes the average *d'* amounted to 2.08, $t(29) = 7.80$, $p < .001$, (SD=1.46), and for the unmasked spatial primes the average *d'* was 1.53, $t(29) = 6.65$, $p < .001$, (SD=1.26). This means that for both the unmasked spatial and the unmasked valence primes the participants were able to discriminate between metaphor-congruent and metaphor-incongruent prime-target pairs with an accuracy significantly exceeding chance performance, suggesting that here they were able to see the primes. These results support the premise, that the masked primes were masked sufficiently to prevent conscious processing, while the unmasked primes were not, allowing for further interpretation of the data.

3.2. Reaction Times for semantic priming

The reaction times (RTs) for the thirty participants were measured in milliseconds (ms) and their median reaction times were calculated over all trials and for all conditions. The means of these medians were subsequently analyzed with a repeated measures ANOVA, which was calculated using three within subject factors with two parameter values each: visibility of the primes (masked vs. unmasked), metaphoric congruence (congruent vs. incongruent), and primetype (spatial vs. valence primes), and there were no between subject factors. This resulted in a 2 × 2 × 2 repeated measures ANOVA. In order to eliminate undue influence of outliers, reaction times that were more than two standard deviations above or below each participant's mean reaction time, here 4.2% of all the RTs, were discarded for the analysis.

The repeated measures ANOVA revealed a significant main effect for visibility, $F(1,29) = 8.13$, $p < .01$, partial $\eta^2 = .219$, masked primes resulted in longer RTs as opposed to unmasked primes . There was also a highly significant main effect of prime type, $F(1,29) = 16.26$, $p < .001$, partial $\eta^2 = .359$, signifying that spatial primes with valence targets were processed faster than valence primes followed by spatial targets. Although this main effect is defined by the prime type, that is whether the primes were spatial or valent, it is impossible to determine whether this effect is due to the primes or the targets: There is no way of knowing whether the participants reacted faster to the spatial primes, or to the valent targets, or whether it is the combination of spatial primes and valent targets that causes these significant faster reaction times. (For means and standard deviations see Table 2 and for graphic representation see Figures 5 and 6 below)

Table 2

Means (M) and Standard Deviations (SD) of the Main Effects for Reaction Time Analysis of Semantic Priming Effects

		M	SD
Prime type*	valence	700	10.2
	spatial	676	9.2
Visibility*	masked	697	10.4
	unmasked	679	9.1
Metaphor-congruence°	compatible	686	9.6
	incompatible	689	9.1

Note. Values are in ms
*p < .05. °p > .05

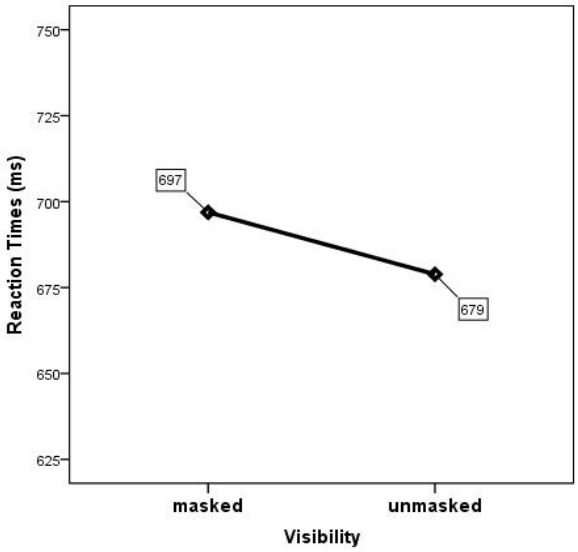

Figure 6. Significant main effect of visibility. RTs are faster when the primes are visible when they are not.

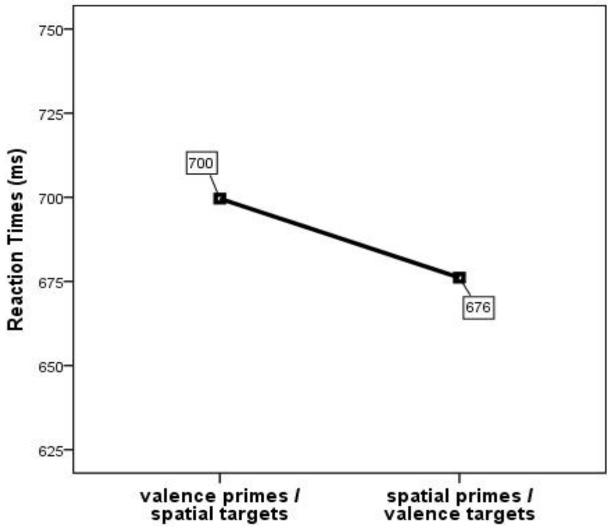

Figure 5. Significant main effect of prime type / target type. Participants responded faster to spatial primes / valence targets.

Unfortunately, the repeated measures ANOVA was not able to confirm a significant main effect for metaphor-congruence, $F(1,29) = 1.75$, $p = .196$, partial $\eta^2 = .057$. Furthermore there were no significant interactions of metaphor-congruence with visibility, $F(1,29) = .975$, $p = .331$, partial $\eta^2 = .033$, nor was there a significant interaction of metaphor-congruence and prime type, $F(1,29) = 2.278$, $p = .142$, partial $\eta^2 = .073$. (See Figures 7 and 8 below for illustration). These results indicate that contrary to our assumption, primes did not facilitate processing-speed for their metaphor-congruent targets. This holds true both in the masked and unmasked conditions, and irrespective of the prime type (valence or spatial).

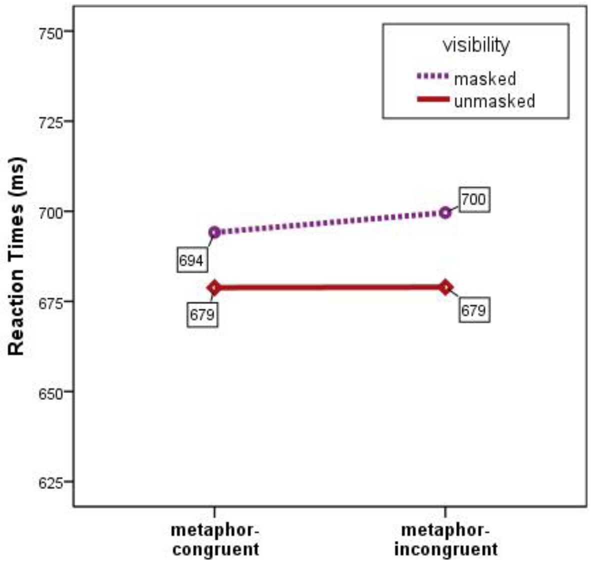

Figure 8. No significant interaction between metaphor-congruence and visibility

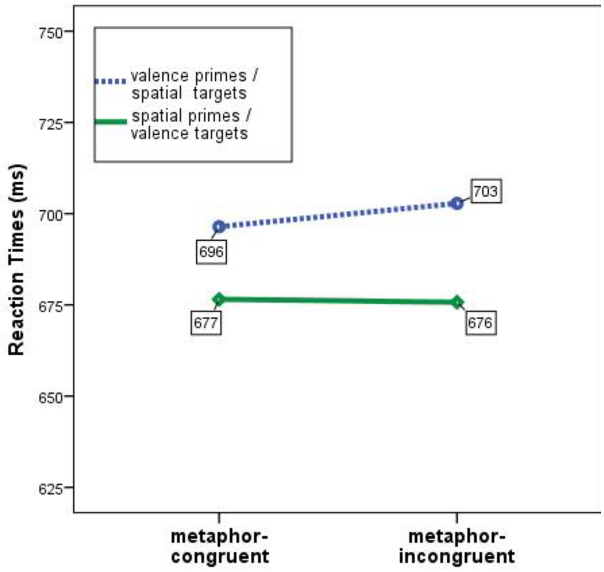

Figure 7. No significant interaction between metaphor-congruence prime type / target type**.**

3.3. Error rate for semantic priming

Another measure of effects in masked priming is the error rate (ER). While reaction times measure the speed with which participants respond to the target, the error rate is a measure of the accuracy of their responses, in this case responses are accurate when the participants correctly categorize the target as either a spatial word or a valence word by pressing the corresponding key. The error rate (ER) is the percentage of false/incorrect responses. These ERs were also evaluated with a 2 × 2 × 2 repeated measures ANOVA, the within-subject factors being: visibility (masked vs. unmasked), prime type (valence vs. spatial), and metaphor-congruence (congruent vs. incongruent).

The repeated measures ANOVA of the ERs showed no significant main effects, which means, that the main effects of visibility and prime type in the RT analysis are not due to a speed-accuracy trade-off. While there was also no significant main effect for metaphor-congruence (F[1,29] = .39, p = .54, partial η^2 = .013), there was a significant interaction between prime type / target type and metaphor-congruence, $F(1,29) = 4.68$, $p < .05$, partial η^2 = .139. In the metaphor-congruent conditions valence primes / spatial targets elicited more mistakes than spatial primes /valence targets, while in the metaphor-incongruent conditions prime type/target type did not seem to have much of an effect. This means that when prime and target were metaphor-congruent, both prime types/target types resulted in similar amounts of errors, as opposed to when primes and targets were metaphor incongruent, where participants tended to make more mistakes when they responded to spatial primes/valence than valence primes /spatial targets. Furthermore, while participants seem to make more mistakes with spatial primes /valence targets when they are metaphor-congruent, than when they are metaphor-incongruent, the effect seems to be reversed for valence primes/spatial targets, Here participants tend to make less mistakes in the metaphor-congruent as compared to the metaphor-incongruent conditions (See Table 3 and Figure 9 below). There was also a significant interaction between visibility and prime type, $F(1,29) = 7.64$, $p < .05$, partial $\eta^2 = .208$, which shows, that when the primes were masked, the error-rates for valence primes / spatial targets and spatial primes /valence targets are very similar. Whereas when the primes are visible then participants have similar error rates for both prime types / target types. (See Table 3 and Figure 10).

Table 3

Means (M) and standard deviations (SD) of the significant interactions in the ER analysis

			M	SD
Prime type x metaphor-congruence	valence primes	congruent	6.83	0.66
		incongruent	5.75	0.66
	spatial primes	congruent	4.92	0.80
		incongruent	5.64	0.66
Prime type x visibility	valence primes	masked	5.39	0.57
		unmasked	5.50	0.76
	spatial primes	masked	7.19	0.80
		unmasked	5.06	0.70

Note. Values are in percent
p<.05

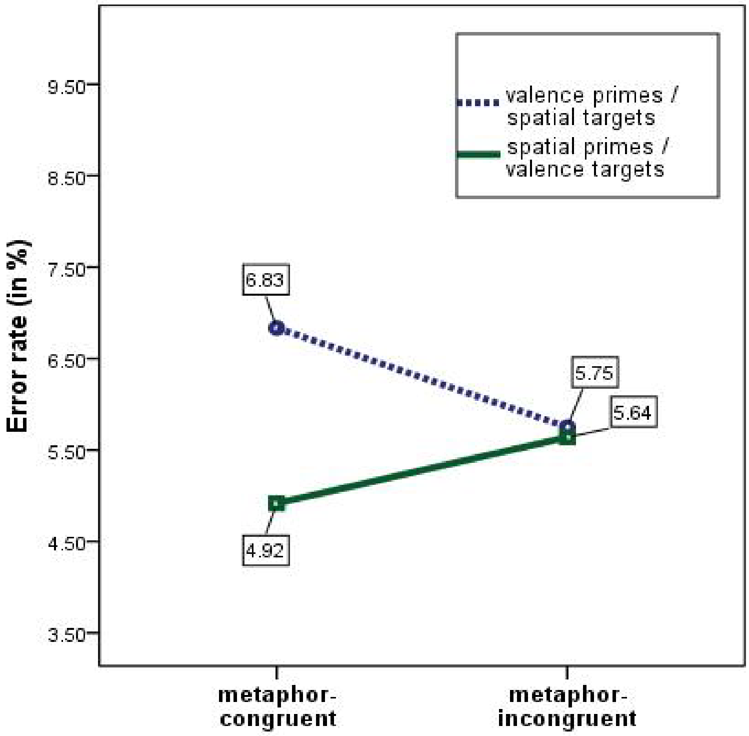

Figure 9. Significant ER interaction between metaphor-congruence and prime type. In the metaphor-congruent conditions more mistakes were made with valent primes (spatial targets) relative to spatial primes (valent targets), whereas in the incongruent condition this difference in error-rate diminishes significantly.

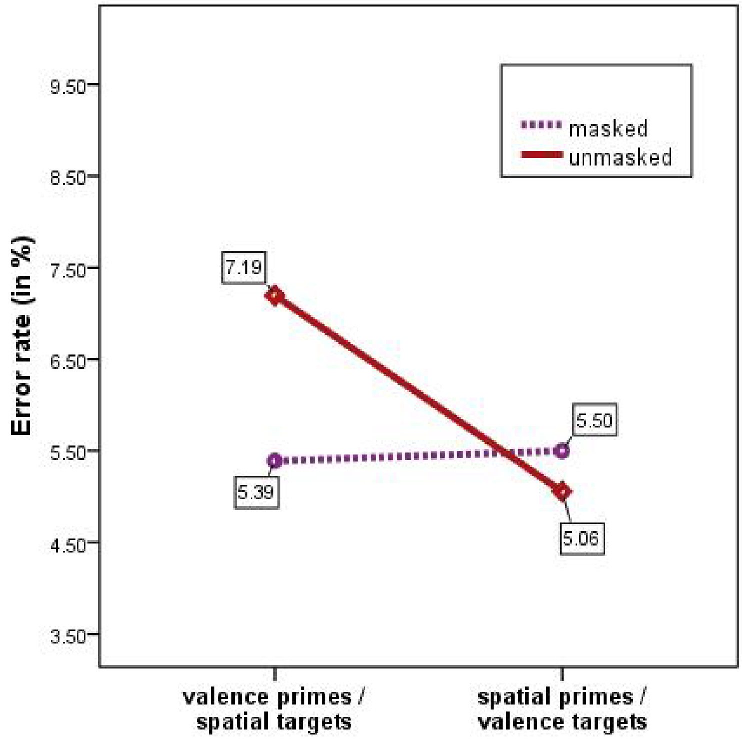

Figure 10. Significant interaction of ER between visibility and prime type / target type. When the primes are masked, ER is similar for valence primes / spatial targets and spatial primes / valence targets. When primes are visible ER is higher for valence primes /spatial targets, than spatial primes / valence targets.

3.4. Reaction time distribution analysis

In a study published in 2008, Kinoshita and Hunt attempted to explain, why previous studies had shown that masked incongruent primes slowed down the reaction times to the targets, relative to a neutral baseline, while masked congruent primes did not seem to significantly speed up the processing time compared to the same neutral baseline (cf. Naccache & Dehaene, 2001), when logically there should be no reason for such an one-sided effect. Kinoshita and Hunt noted that this might have something to do with the fact that RT distributions are usually not normal, but positively skewed. Therefore, they conducted two experiments with congruent, incongruent and neutral masked primes, requiring semantic categorization tasks of the targets. In addition to the conventional analysis of the mean RTs the authors also examined the RT distributions, “...by first sorting the RT observations from the fastest to slowest, and then dividing them into *N* bands, each containing an equal number of observations (e.g., the fastest 10%, the next 10%, etc.).” (Kinoshita & Hunt, 2008, p. 1327). Thus they created 9 RT bins, or Quantiles, and found that for their first experiment, in a 9 × 2 ANOVA, with quantile and congruence as factors, there was a main effect for congruence and a significant interaction between congruence and quantile. Thus confirming that "...there is a disproportionate slowdown of the congruent condition in the later quantiles, which results in a disappearance of the congruence effect." (Kinoshita & Hunt, p.1327). This means that within the faster RTs there was a congruence-effect that could not be found in the slower RTs. In their experiment 2, Kinoshita and Hunt's (2008) were able to substantiate these findings, elaborating that this dwindling congruence-effect in slower RTs is particularly true for primes that were also used as targets. While the authors remain indecisive about the cause, they provide compelling argumentation that the congruence-effect is reduced over time, which may result in the masking of the congruence-effect in conventional RT analysis, and advocate reaction time distribution analysis as a method to confirm category congruence-effects for masked primes.

Contrary to the study published by Kinoshita and Hunt (2008), the present study did not use a neutral baseline to which congruent or incongruent conditions could be compared, which makes it more difficult to determine whether there is an asymmetry in the congruence-effect vs. the incongruence-effect. All the same, it could be possible that the repeated measures ANOVA was not able to reveal a methaphor-congruence effect, because this effect was lost over the slower reaction times. This possibility is exacerbated by the fact that Kinoshita and Hunt found that a reduction of the congruence-effect in slower RTs is particularly prominent when primes were used as targets as well, such as they are in the current study. Therefore, in order to account for the possibility of a disproportionate RT distribution of a metaphor-congruence-effect, the RT distribution was analyzed in a procedure similar to the one used by Kinoshita and Hunt. The RTs were sorted from fastest to slowest, and divided into five equal time-bins, or quintiles. Then the data were analyzed with another repeated measures ANOVA, however this time with quintile as another within-subject factor, in addition to the ones mentioned above. This resulted in a 5 × 2 × 2 × 2 repeated measures ANOVA, with the following within-subject factors: quintile (5 time bins), visibility (masked vs. unmasked), prime type (valence vs. spatial), and metaphor-congruence (congruent vs. incongruent). Where Mauchly's test of sphericity was significant, and sphericity could therefore not be assumed, a Greehouse-Geisser correction was applied and the corresponding Epsilon values are reported.

The repeated measures ANOVA renders a significant main effect of quintile, $\varepsilon = 266$, $F(1.06,30.80) = 301.46$, $p < .001$, partial $\eta^2 = .912$, in addition to the same main effects, of visibility ($F[1,29] = 7.29$, $p < .05$, partial $\eta^2 = .201$) and prime type ($F[1,29] = 12.68$, $p < .05$, partial $\eta^2 = .304$) that were found and detailed the previous analysis of the reaction times. Just like in the previous RT analysis, reaction times were faster in the unmasked conditions relative to the masked conditions, and faster when spatial primes were presented before affective targets than when valence primes were presented before spatial targets. However, supplementing the previous findings, there was also a significant interaction between quintile and prime type, $\varepsilon = .507$, $F(2.03,58.81) = 7.17$, $p < .05$, partial $\eta^2 = .198$, which shows, that spatial primes/valence targets were processed faster than valence primes/spatial targets when the RTs were generally faster (in the faster bins), but as the reaction times generally became slower (slower bins), this difference between reaction times to the different prime types/target types tends to disappear. This means that the effect of prime type/ target type is restricted to the faster response times. (See Figure 11 below).

The RT distribution analysis failed to reveal a significant main effect for metaphor-congruence, $F(1,29) = 0.73$, $p = .237$, partial $\eta^2 = .048$, nor was there a significant interaction between metaphor-congruence and quintile, $\varepsilon = .392$, $F(1.57,45.42) = 1.26$, $p = .288$ partial $\eta^2 = .041$. Therefore, contradictory to the results proffered by Kinoshita and Hunt (2008), there was no significant (metaphor)congruence-effect that was prominent in trials with faster reaction times, but diminished for slower RTs (see Figure 12). Therefore, there was no congruence effect that merely diminished over time. There were also no significant interactions between congruence and prime type, or congruence and visibility, nor any three- or four-way interactions.

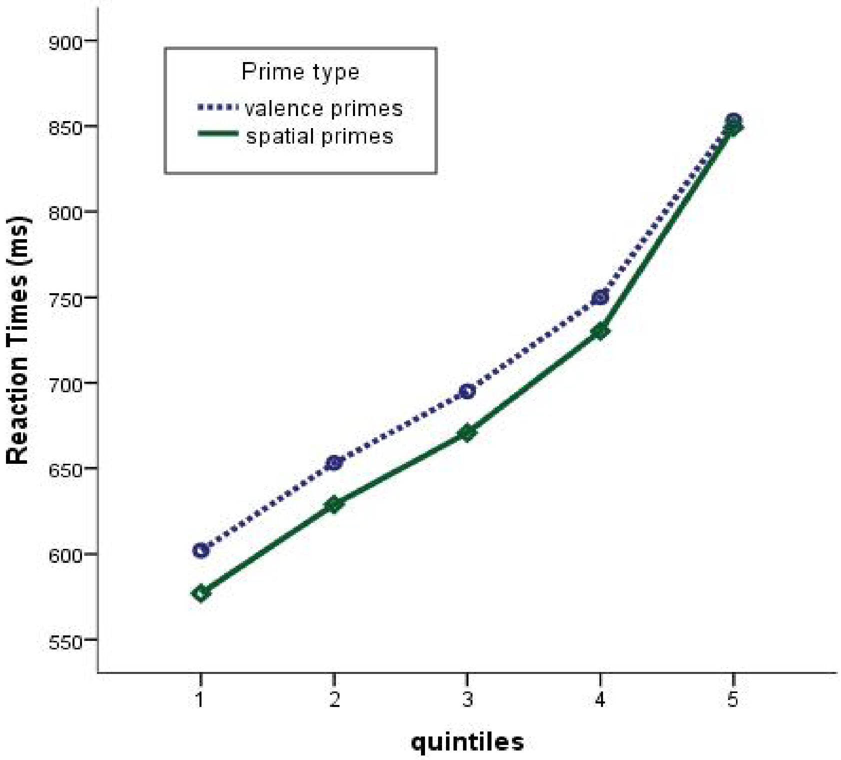

Figure 11. Significant interaction between quintile and prime type/target type. As reaction time increases, the differences between the reaction times of spatial primes / valence targets (green) and valence primes / spatial targets decreases.

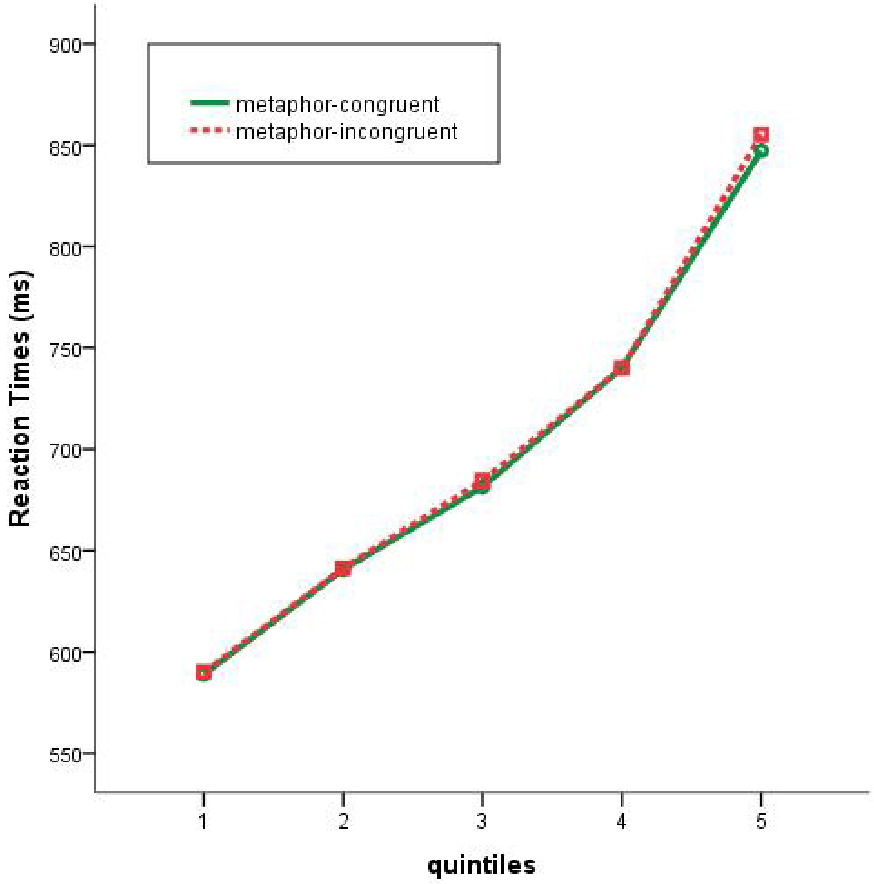

Figure 12. No significant interaction between quintile and metaphor congruence. Metaphor-congruent trials (green) and metaphor-incongruent trials (red) have very similar RTs across the quintiles.

4. Discussion

While, neither the reaction time analysis, nor the error-rate analysis revealed a significant main effect of metaphor-congruence, participants responded quite significantly slower to valence primes / spatial targets compared with spatial primes / valence targets, as was reflected by the powerful main effect of prime type in the RT analysis. At the same time the significant interaction between the error-rates of prime type and metaphor-congruence showed that when primes and targets were metaphor-congruent, participants also tended to make more errors with valence primes / spatial targets than with spatial primes / valence targets. This could indicate that, similar to what Lakoff and Johnson (1999) and also Meier and Robinson (2004) suggested, metaphors are unidirectional: while the valence stimuli prime spatial processing, the spatial stimuli do not prime the valence assessment in a metaphoric fashion. However, in the present experiment, the lower error-rates for spatial primes /valence targets in the metaphor-congruent conditions compared to the metaphor incongruent conditions. As there was no such improvement, but rather a worsening, between metaphor-congruent and metaphor-incongruent conditions for valence primes / spatial targets this could suggest a unidirectional priming effect in the opposite direction than suggested by these authors (i.e. that *up/down* primes *positive/negative* and not vice versa). This interpretation, however, would not explain the relatively compelling increase in error-rate for the valence primes / spatial targets between the metaphor-congruent and incongruent conditions.

Perhaps, this increase in error-rate for the valence primes/ spatial targets in the congruent conditions, is because the valence primes cause a metaphor-congruence effect, but that this effect confused participants who had to respond to the target whilst ignoring its meaning, thus inhibiting rather than facilitating the correct response and causing more mistakes in the congruent conditions where the meanings could be conflated. This could be understood analogously to McErlee and Nordlie (1999) who found, that participants were less likely to judge metaphors as literally false. If participants were to process prime and target in a metaphoric fashion, it might prime the embodied entity making it more difficult to form subsequent independent assessments, such as what type of word the target was (or as in McErlee and Nordlie, whether the sentence is literally true). It would make sense for this inverse metaphor-congruence effect to work primarily in one direction, for if metaphors help humans think abstract concepts, by thinking of them in terms of concrete concepts, it is logical that these concrete concepts prime the metaphor-consistent abstract concepts. However, Lakoff and Johnson (1999) conceded that humans can think of certain concrete concepts without using metaphor. Therefore, such concrete concepts as the spatial dimension would not need to enlist abstract concepts for comprehension.

On the other hand, it is equally possible, that significant RT advantage of spatial primes /valence targets, and the lower ER in metaphor-congruent conditions for spatial primes/valence targets is because either the spatial primes or the valence targets were more salient. It is possible that perceptual features of either the primes or the targets may have influenced the processing speed and error-rates, as well as that perceptual similarities between the primes and targets may have had an influence that could falsely be interpreted as an interaction between prime type and metaphor-congruence. However, while perceptual confounding is a very plausible explanation for the main effect of prime type /target type, because there seems to be many feature-overlaps within the spatial (e.g., steigend/sinkend, gehoben/gesenkt, hinauf/hinab/herab, aufwaerts/abwaerts) and valence categories (e.g., freudig/froehlich, furchtsam/frustriert), it does not sufficiently explain the interaction between prime type/target type and metaphor-congruence not only because there is less feature-overlap between the categories, but also because Klauer, Eder, Greenwald, and Abrams (2007) showed that congruence effects were feature-independent, because they found congruence effects even when there was “...more overlap at the word-fragment level between incongruent primes and targets than between congruent primes and targets...” (p.71).

There were no further indications of potential effects due to metaphor-congruence, and the reaction time analysis across different time-bins also yielded no hidden metaphor-congruence effect in faster or slower reaction times. There was also no interaction between visibility and congruence, which could have suggested a congruence effect in the conditions for which the primes were visible, as opposed to when they were masked. It can therefore not be argued that there was a metaphor-congruence effect but that it was merely not processed automatically. However, rather than jumping to the conclusion that this means that the link of up with positive, and down with negative, is tenuous and neither embodied nor semantically linked sufficiently so that activation of one facilitates processing of the other, it is important to look at some of the factors, that might have prevented or mitigated further metaphor-congruence effects.

The presently used semantic categorization task, which required participants to ignore the dimensional properties (i.e. up/down or positive/negative) of the targets (and also of the primes), and merely categorize the targets as either being spatial or valent, served several purposes. For one, as previously mentioned, this design was intended to prevent a category learning effect. Abrams, Klinger and Greenwald (2002) suggest that the accumulated practice throughout the experiment in subliminal priming experiments can cause short term learning/associations that can even override the long-term established knowledge. They assert that this is on the basis of word-to-category mappings which are “associations of words to the categories that are used to classify them in the experimental task” (p. 101). Therefore, the present experiment attempted to circumvent ad hoc learned associations caused by the mappings made throughout the experiment, by asking participants to use different categories to classify the words, to ensure that the priming-effects would be due to the long-term underlying metaphoric and embodied connection between verticality and affect. Furthermore, in order to test for the implicit nature of this connection it was also deemed important to not draw too much attention to it in the experimental task.

However, setting a categorization task that is different from the metaphoric-categorization necessary for the anticipated congruence effects might have prevented the stimuli from being processed in this metaphor-congruent fashion. This assumption is in line with the findings reported by De Houwer, Hermans, Rothermund, and Wentura (2002), who maintained that particular semantic categorization tasks are task-sensitive, as opposed to for example pronunciation tasks, when priming affectively. De Houwer et al. presented words with positive and negative valence as primes (e.g., peace, death) and targets (e.g., butterfly, snob), in a congruent and incongruent fashion, but asked participants to categorize these targets as (a) belonging to the category of animal or a person in Experiment 1, and either (b) being an animal or a thing or (c) being positive or negative in Experiment 2. Their findings showed, that not only was there no valence-congruence effect between primes and targets when participants had to categorize the targets as animal or person in Experiment 1, but also verified that there was no affective congruence effect between the primes and the targets, when the targets needed to be categorized as animal vs. thing, even when there was indeed an affective congruence effect of primes to targets when participants were required to categorize the targets as positive vs. negative in Experiment 2. This led De Houwer et al. to believe that "affective priming did not occur in the semantic categorisation task because the responses were unrelated to valence" (p. 658).

While many experiments have shown that task-irrelevant features often influence response, it may be, that similarly do the results found by De Houwer et al., in the present experiment the metaphoric association between affect and space, may not have caused a congruence effect because it cannot become manifest independent of the task. That means participants may have successfully focused on the attributes necessary to complete the task, which was the semantic category of the primes and targets, and that categorization may have undermined any other attributes. Furthermore since the primes were always category incongruent with the target, it is possible that participants learned to respond to the semantic category of the primes (valence vs. spatial) as opposed to the target, or that this learned category-mapping may at least have facilitated responses. A persistent incongruent relationship, is nonetheless a relationship, and allows anticipation of the targets: participants may have learned to expect spatial targets when primes were valence, and valence targets when primes were spatial. This may also have overshadowed the metaphor-congruence effect.

Another potential reason, why no other metaphor-congruence effects were found, may have been due to stimulus-response mappings, which were also examined in this study, and are described below.

5. Stimulus-Response Mapping

5.1. Theoretical Background

As previously mentioned, Holender and Duscherer (2004) assert that another important effect—next to prime-target (metaphor)congruence—that needs to be taken into consideration is the stimulus-response compatibility (SRC) effect. Past research has found, that properties of a stimulus can influence the response, even if they are task irrelevant. The frequent assumption is that SRC effects occur because a "...stimulus triggers its feature-corresponding response….In the compatible condition (i.e., when stimuli and responses correspond), this results in faster selection of the correct responses. In the incompatible condition (i.e., when stimuli and response do not correspond), however, the stimulus always activates the incorrect response. This results either in an error or in longer reaction times (RTs), depending on whether the wrong response can be suppressed or not and whether the correct response is initiated " (Lippa & Adam, 2001, p.156). Therefore in the present study, the observed effects might not necessarily be due to the semantic priming effects, but due to the fact that either the primes or the targets directly elicit a response.

5.1.1. Spatial Stimulus-Response Mapping.

Most pertinent for the present study are the spatial *Stroop effect* and the *Simon effect*. According to Lu and Proctor (1995) "The Simon effect refers to the fact that responses are faster when the stimulus location corresponds to the location of the assigned response than when it does not." (p.174). The most prominent example of the Simon effect, is the finding that if, for example a participant has to respond with his/her left hand to green, and with his/her right hand to red, then the participant will respond faster if green is presented on the left, than if it is presented on the right (cf. Craft & Simon, 1970). The spatial Stroop, as described by Lu and Proctor (1995), also concerns the variations of reaction times in relation to response congruent and response incongruent spatial information that isn't relevant for the task. However, unlike the Simon task which typically involves stimulus material that are dissimilar from the response (in this case it is nonspatial stimuli like color), a spatial Stroop task is commonly conducted with stimuli that contain the same type of information, usually spatial (e.g. arrows or spatial words, such as "up" or "north").

Interestingly, although this distinction between Simon effect and spatial Stroop effect is generally not found in such concise and explicit wording within the literatures, the two phenomena are generally treated as separate, notwithstanding the fact that one of the earlier examples of what is termed the spatial Stroop effect was illustrated in a study that was actually published by Simon and Rudell (1967). In this study (originally designed to prove hemispheric speech recognition dominance in accordance with handedness), the authors presented the words “left” and “right” auditorily through headphones separately to the participants' left and right ears. Participants were then required to respond by pressing a set of two keys placed next to each other (10 inches apart) with their left and right index-finger respectively. They were to press the left key with their left index-finger when they heard the word “left” and the right key with their right index-finger when they heard the word “right”, irrespective of which ear this word was presented to. Simon and Rudell found, that there was a significant interaction between command (“left” vs. “right”) and ear stimulation (left ear vs. right ear), such that “...RT was markedly faster when the "right" command was heard in the right ear than when it was heard in the left ear (390 versus 434 msec). Similarly, RT to the "left" command was faster when it was heard in the left ear than when it was heard in the right ear (385 versus 424 msec)” (Simon & Rudell,1967, p. 302). The authors came to the conclusion that “Results clearly indicated that speed of processing verbal commands (i e., the words "right" and "left") was affected by a cue irrelevant to the task itself, that is, the ear in which the command was heard” (p.303). Unfortunately Simon and Rudell did not switch the response task, so that participants would have to respond with their left hand to the word “right” and with their right hand to the word “left”, so it is not possible to determine, whether this effect occurred due to spatial Stroop stimulus-stimulus congruence effect, or a stimulus-response congruence effect. However, McClain (1983) was able to show a spatial Stroop effect in the identification task of low and high pitches, such where stimulus-response compatibility significantly influence the congruence-effects.

Similar effects have been shown, regarding visual stimuli. Virzi and Egeth (1985), found that when participants had to name the words “left” or “right” that were presented to the left or right of a fixation cross, there was no significant difference in the reaction times between compatible conditions (“left” presented on the left side, and “right” presented on the right side) and incompatible conditions (“left” presented to the right side of the fixation cross, and “right” presented to the left side). However, if participants had to indicate manually if the word said “left” by pressing a left-hand button or “right” by pressing a right-hand button, then there was a significant difference in the RTs between the compatible and incompatible conditions. This suggests, that there was a spatial Stroop stimulus-response interference effect that influenced the Stimulus-stimulus congruence effect. This finding was supported by Proctor and Wang (1997) who were able to demonstrate robust spatial-Stroop effects, most notably for the present study, to the words “left” and “right” presented at the center of a computer screen and bimanual keypress responses. Here, participants were required to respond with their left index-finger and press a specific button on the far left of a centered keyboard (“*z*”-button on an American keyboard) to the word “left” stimulus and to use the right indexfinger to press a right key on the keyboard (“/”-button on an American keyboard) for the word “right”. Stimulus-response compatible (left/left, right/right) conditions were significantly faster and more accurate than incompatible conditions. Vu and Proctor (2004) further substantiated these findings, reporting SRC effects to the words “left” and “right”, presented at the center of the screen, and left and right keypresses even when stimulus response compatible and stimulus response incompatible trials were mixed, as they were in the present study.

Bauer and Miller (1982) found that this effect does not only apply to straightforward feature corresponding dimensions of “left” with left and “right” with right, but also in a “perpendicular” fashion, where stimuli presented on the left or right, produced SRC effects in combination with up and down, depending on which hand the participants were required to respond with. When participants responded with their right hand, they responded faster to left stimulus presentation that required downward responses (*left/down mapping*), and right stimuli that required an upward response *(right/up mapping)*. When they had to respond with their left-hand the mapping was reversed. Such a perpendicular mapping of the vertical dimension to the horizontal one, is called *orthogonal stimulus-response compatibility*. The experimental setup in the experiment conducted for the present thesis however required a bimanual, not unimanual, key-press response, such as Proctor and Cho (2003) have investigated. The authors found that, while the orthogonal mapping varied with the keyboard position relative to the body-midline, there was a slight preference of the left/down to the right/up mapping as indicated by slightly faster RTs for compatibility in this mapping at the centered condition (relative to the body-midline).

Therefore orthogonal compatibility for spatial primes was defined such that *“up” stimuli* were compatible with the *right-hand responses* and *“down” stimuli* were compatible with the *left-hand responses*.

5.1.2. Valence Stimulus-Response Mapping

There could also be an orthogonal stimulus response effect for the valence stimuli. In an effort to explore whether conceptual metaphors are inherently embodied through sensorimotor conflation as suggested by Lakoff and Johnson (1999), or internalized linguistic and symbolic conventions, Casasanto published a study in 2009, where he details experiments investigating the common association of good with right vs. left with bad. Similar to the frequently found linguistic and symbolic associations of good with up, and bad with down, so Casasanto argues there is also a profound linguistic and symbolic connection linking positive with the right (side of the body) and negative with the left (side of the body). As examples for this association he cites, among other things, the common English idioms “'the right answer' and 'my right-hand man' [which] associate good things with rightward space, and complementary idioms like 'out in left field' and 'two left feet' [which] associate bad things with leftward space.” (Casasanto, 2009, p. 353). Casasanto also gives “nonlinguistic conventions” as examples, like “...Islamic doctrine, [where] the left hand should be used for dirty jobs, whereas the right hand is used for eating. Likewise, the left foot is used for stepping into the bathroom, and the right foot for entering the mosque.” (Casasanto, 2009, p.353). He proposes, what he calls the *body-specificity hypothesis*, which states that if abstract knowledge, and metaphors specifically, are embodied through our bodily, sensory, and introspective experiences, then each person should experience this embodiment differently in accordance to their own unique bodily qualities:

> “That is, if concepts and word meanings are constituted in part by simulations of people’s own perceptions and actions, then people with different bodily characteristics, who interact with their physical environments in systematically different ways, should form correspondingly different mental representations” (Casasanto 2009, p. 351)

Therefore, if the common association of right with positive and left with negative were due to embodied experiences and positive associations with the dominant side of the body, this link should be different for left-handed individuals, and consequently the linguistic assimilation that links right with positive and left with negative would be merely an artifact caused by the dominance of right-handed individuals in the population. If, however the connection is merely an internalization of the existing linguistic and social conventions, then left-handed and right-handed participants should react similar.

To prove his body-specificity hypothesis Casasanto required left- and right-handed participants to draw a “good “ and a “bad” animal in one of two boxes that were either left or right (or at the top or bottom for the control) of a cartoon figure. A majority of the left-handed participants drew the good animal in the left box, and the bad animal in the right box, whereas a majority of the right-handed participants drew the good animal in the right box and the bad in the left, resulting in a “significant correlation between the handedness of the participant and the left–right placement of the good and bad animals” (Casasanto, 2009, p. 354). Verbal indication of placement of the good and bad animals supported mainly a significant preference of left-handed participants for associating the left side with good animals, and an attribution task of positive and negative qualities in drawn alien creatures that were presented in two columns showed that right-handed participants tended to attribute positive qualities to the right creatures and negative qualities to the left creatures, while left-handed participants tended towards the opposite mapping. Casasanto and Chrysikou (2011) later further supported this body-specificity hypothesis by testing the valence – left/right response-compatibility effect for right-handed participants who had suffered a stroke which handicapped their dominant hand, forcing them to use their left hand as the dominant hand

Casasanto (2009) and Casasanto and Chrysikou (2011) offer solid arguments that advocate embodiment of abstract language in general, adding that this embodiment is body-specific; and very importantly, they provide evidence for embodiment of positive and negative along the horizontal body-axis, frequently in accordance with hand-dominance (dominant hand linked with positive). Since in the present experiment participants were required to respond with their left or right index-finger to categorize the target, it is also important to take this horizontal-valence embodiment into account. Therefore, in order to account for the potential influence of the profuse linguistic and cultural association of positive with right, and negative with left as expounded by Casasanto (2009), while simultaneously incorporating the possibility for body-specific embodiment of emotion, the orthogonal compatibility for valence was analyzed exclusively for the right-handed participants (data from the one left-handed participant was excluded). Consequently, orthogonal compatibility for the valent stimuli was defined such that *positive* stimuli are compatible with a *right response*, and *negative* stimuli are compatible with a *left response*.

5.2. Results Orthogonal Stimulus-Response Compatibility Effects

In the present experiment there were two types of stimuli: the primes and the targets. It is conceivable that the stimulus-response compatibility effects could be due to the primes, the targets, or both. While the participants are required to respond to the targets, the primes may still facilitate an orthogonally compatible response, and/or inhibit an orthogonally incompatible response, either directly or by pre-activating a subsequent target-response compatibility effect. If, for example the prime is the word “funny” and the target is the word “up”, and the task is to respond right to spatial targets, then the prime (“funny”) would be orthogonally compatible (as we defined it for valence stimuli) with the rightward respond and could facilitate it, just as the target word “up” is orthogonally compatible with a rightward response and could in turn cause an orthogonal compatibility effect. Furthermore, the prime-response compatibility or incompatibility can interact with the target-response compatibility or incompatibility. In the above mentioned example, the prime would be response compatible and that could

In order to evaluate the orthogonal stimulus-response-effects the two different key assignment response groups were analyzed separately: one group had to respond right to spatial targets and left to valence targets, the other reversely). The reaction times (RTs) and error-rates (ERs) were examined with a $2 \times 2 \times 2 \times 2$ repeated measurement ANOVA, the within subject factors being visibility (masked vs. unmasked), prime type (valence vs. spatial), prime-response compatibility (compatible vs. incompatible), and target-response compatibility (compatible vs. incompatible).

5.2.1. Group 1 Reaction Times

Participants in group 1 were required to press the right key for spatial targets and the left key for valence targets. The stimulus-response analysis for this group revealed, next to a significant main effect of prime type (F [1,14] = 5.58, $p < .05$, partial $\eta^2 = .285$), that similar to the previous RT-analyses showed that spatial primes/ valence targets were processed faster than valence primes/spatial targets (see Table 5 below) , also showed a highly significant main effect of target-response compatibility, $F(1,14) = 12.33$, $p < .01$, partial $\eta^2 = .468$. Interestingly RTs in the target-response incompatible conditions were faster (M=665 ms) than in the compatible condition (M=680 ms), which contradicts the assumptions made in accordance to Casasanto (2009), and Cho and Proctor (2003). However, there was also a significant interaction between prime type and target-response compatibility, $F(1,14) = 12.94$, $p < .01$, partial $\eta^2 = .480$, that showed that the only spatial primes/ valence targets were evaluated significantly faster in the target-response incompatible conditions than in the target-response compatible conditions, whereas for valence primes / spatial targets there was hardly any difference in RTs between the target-response incompatible and the compatible conditions. The counter-intuitive main effect of target-response compatibility is therefore probably due to the faster processing of spatial primes / valence targets in the incompatible conditions. Similarly the main effect of prime type, which showed that valence primes /spatial targets were responded to faster, could be partly due to the interactive effect of target-response compatibility and prime type. (See Figures 13 and 14 and Tables 4 and 5 below).

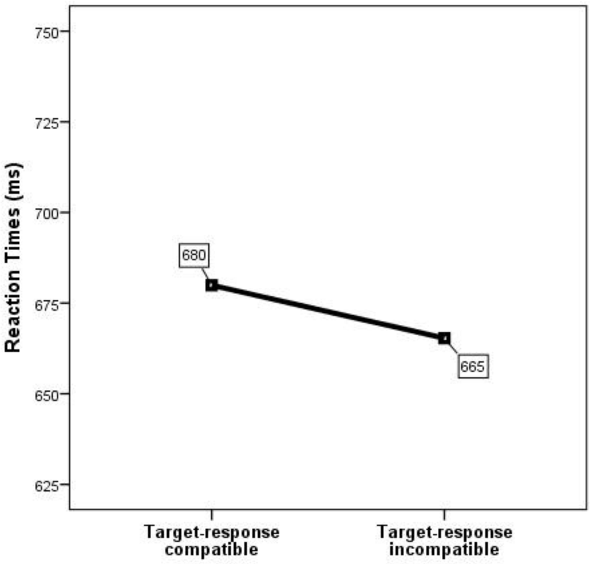

Figure 13. Significant main effect of target-response compatibility. As can be seen, the target-response incompatible conditions result in shorter reaction times.

Table 4

Means and standard deviations of significant main effects for overall RT compatibility analysis Group 1

		M	SD
Prime type	spatial	665	10.4
	valence	681	9.3
Target-response compatibility *	compatible	680	8.9
	incompatible	665	10.0

Note.
Values are in ms
p<.05 *p<.01

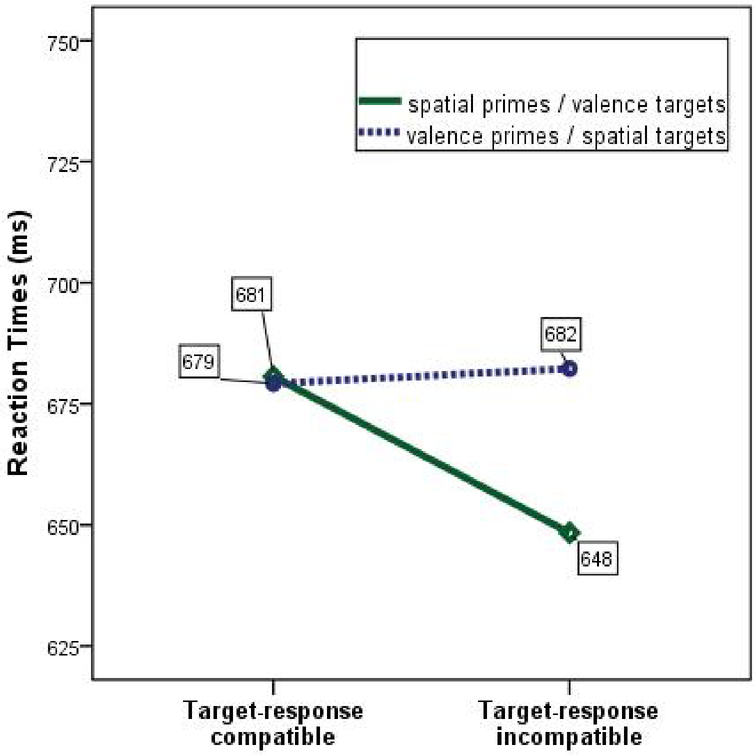

Figure 14. Significant interaction between prime type and target-response compatibility. When the target is compatible with the response, both valence primes /spatial targets and spatial primes / valence targets result in similar reaction times. However if the targets are incompatible with the responses, then valence primes / spatial targets require longer more processing time, than spatial primes / valence targets.

Table 5

Means and standard deviations of the significant interaction for overall RT compatibility analysis Group 1

			M	SD
Prime type x Target-response compatibility	spatial	compatible	681	10.9
		incompatible	648	10.9
	valence	compatible	679	9.2
		incompatible	682	10.3

Note.
Values are in ms
p<.01

In addition to these significant interactions the repeated measures ANOVA also disclosed almost significant interactions of prime type and prime-response compatibility, $F(1,14) = 4.42$, $p = .054$, partial $\eta^2 = .240$, and an almost significant interaction of visibility and prime-response compatibility, $F(1,14) = 4.22$, $p = .059$, partial $\eta^2 = .232$. The almost significant interaction between prime type and prime-response compatibility shows, that the primes may also be subject to a response compatibility effect. Similar to the effects seen in the interaction of prime type and target-response compatibility, so here too the spatial primes / valence targets resulted in faster reaction times in the prime- response incompatible conditions, whereas valence primes / spatial targets resulted in slower RTs in in the prime-response incompatible conditions, compared to the compatible conditions. The almost significant interaction of visibility and prime response compatibility shows that the RT advantage for incompatible conditions is more pronounced in the masked conditions than in the unmasked conditions. (See Table 6 and Figure 15 below).

Table 6

Means and standard deviations of almost significant interactions for overall RT compatibility analysis Group 1

			M	SD
Prime type x Prime-response compatibility	spatial	compatible	668	10.8
		incompatible	661	10.2
	valence	compatible	679	9.3
		incompatible	683	9.7
Visibility x Prime-response compatibility	masked	compatible	676	8.8
		incompatible	669	7.8
	unmasked	compatible	671	11.4
		incompatible	674	11.9

Note.
Values are in ms
p>.05

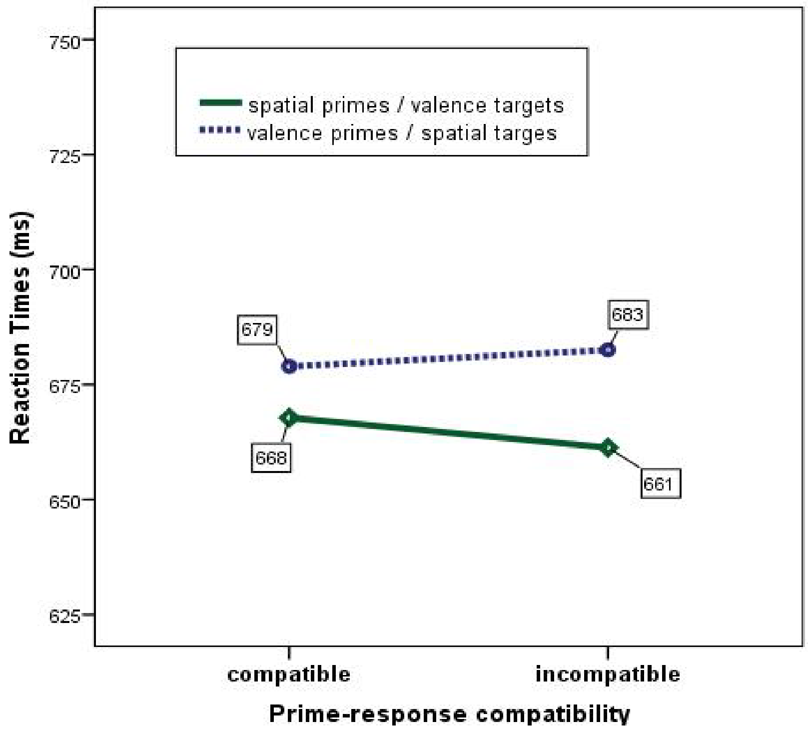

Figure 15. Almost significant interaction between prime type and prime-response compatibility in overall RT analysis of response compatibility in Group 1. For spatial primes / valence targets (green), RTs are faster in the incompatible conditions compared with the prime-response compatible conditions. For valence primes / spatial targets RTs are faster in the prime-response compatible conditions than the incompatible conditions.

In order to isolate the valence and the spatial orthogonal stimulus-response compatibility effects, separate follow-up ANOVAs were conducted for masked spatial primes, unmasked spatial primes, masked valence primes and unmasked valence primes. The within-subject factors for these follow-up ANOVAs were prime-response compatibility (compatible vs. incompatible) and target-response compatibility (compatible vs. incompatible), resulting in a 2 × 2 design. The follow-up ANOVA for the masked spatial primes / valence targets yielded a highly significant effect for target-response compatibility $F(1,14) = 22.84$, $p < .001$, partial $\eta^2 = .620$. Again this effect was inverse to what was expected, responses were faster in the incompatible conditions (M=650ms), than in the compatible conditions (M=685). This means that when the primes were masked spatial words, then the participants responded significantly faster to response incompatible valence targets than to response-compatible valence targets. There was also an almost significant main effect of prime-response compatibility $F(1,14) = 4.55$, $p = .051$, partial $\eta^2 = .245$. Here too, RTs were faster for the response-incompatible conditions (M=662) compared to the response-compatible conditions (M= 673). This means that response-incompatible spatial primes resulted in faster responses to the valence targets. However, there was no significant interaction between prime-response compatibility and target-response compatibility. (Figures 16 and 17 below show the significant target-response compatibility and the almost significant prime-response compatibility for the masked spatial primes). The follow-up ANOVA for unmasked spatial primes / valence targets, revealed only a significant main effect for target-response compatibility, $F(1,14) = 12.88$, $p < .05$, partial $\eta^2 = .479$. Similar to the target-response compatibility effect found for the masked spatial primes, the target-response incompatible trials resulted in faster RTs (M=647) than the target-response compatible trials (M=677).

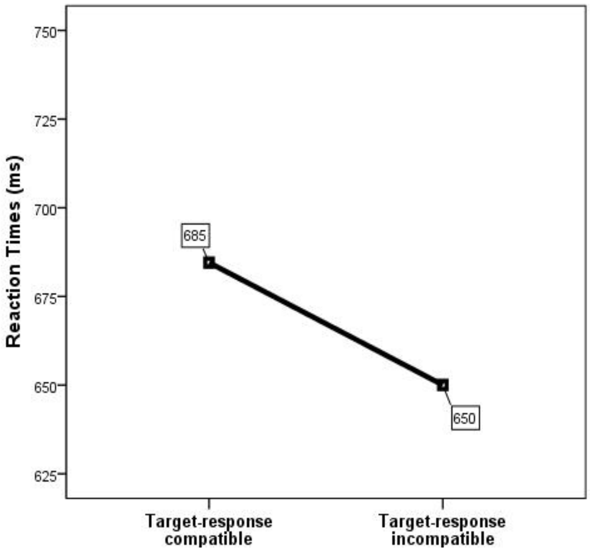

Figure 16. Powerful inverse target-response compatibility effect in the RT follow-up analysis for masked spatial primes / valence targets in Group 1. Responses are faster in the target-response incompatible conditions.

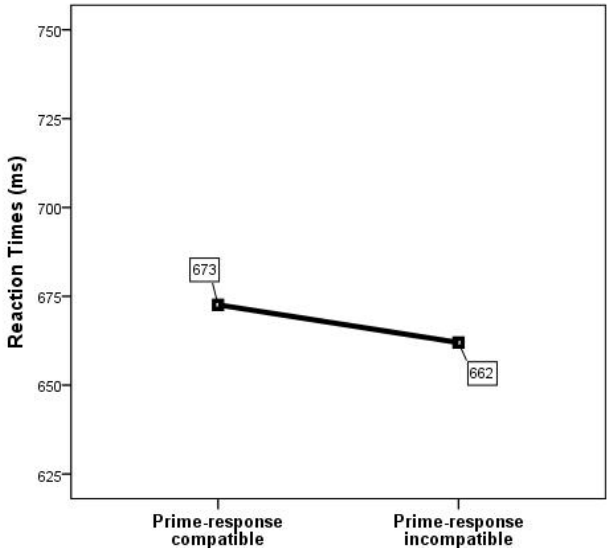

Figure 17. Almost significant inverse prime-response compatibility effect in the RT follow-up analysis for masked spatial primes / valence targets in Group 1. RTs are faster in the prime-response incompatible conditons.

The follow-up ANOVAs for the masked and the unmasked valence primes / spatial targets did not divulge any further significant main effects of either prime-response compatibility or target-response compatibility, nor was there a significant interaction of the two.

5.2.2. Group 1 Error-Rates

As mentioned above, the Error-rates (ERs) were also analyzed first with a 2 × 2 × 2 × 2 ANOVA, analogously to the analysis RTs. This analysis showed a significant interaction between prime type and target-response compatibility, $F(1,14) = 5.63$, $p < .05$, partial $\eta^2 = .287$. Similar to the results found in the RT analysis, spatial primes / valence targets were subject to an inverse target-response compatibility effect: less mistakes were made in the incompatible condition, than in the compatible condition, which indicates that the faster RTs for incompatible spatial primes / valence targets were not due to a speed-accuracy tradeoff. For the conditions with valence primes/ spatial targets, the ANOVA revealed a target-response compatibility effect in the anticipated fashion: participants made fewer mistakes in the compatible conditions than the incompatible conditions. (See Table 7 and Figure 18 below detail these results). The remaining main effects and interactions were all not significant for the analysis of the overall effects.

Table 7

Means and standard deviations of Significant interactions for overall ER analysis of Group 1

			M	SD
Prime type x Target-response compatibility	spatial	compatible	6.61	1.91
		incompatible	4.33	0.95
	valence	compatible	4.56	0.99
		incompatible	7.78	1.11

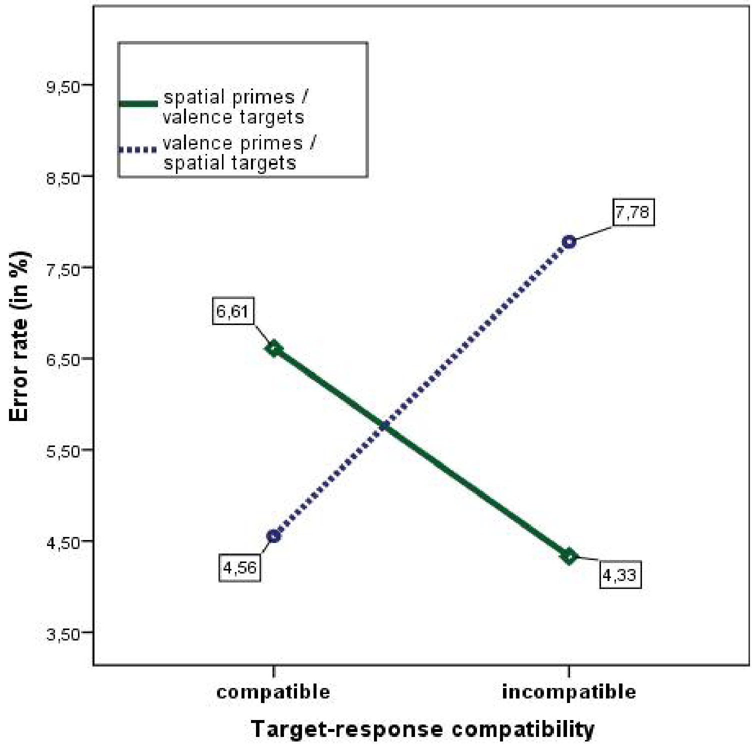

Figure 18. Significant Interaction between prime type / target type and target-response compatibility of ER in Group 1. There is a target-response compatibility effect for valence primes/spatial targets, and an inverse target-response compatibility effect for spatial primes/valence targets

Follow-up ANOVAs in accordance with those for the RTs were also calculated for the ER, and for spatial primes / valence targets. These revealed only a significant main effect of prime-response compatibility in the masked condition: $F(1,14) = 6.89$, $p < .05$, partial $\eta^2 = .330$. This was an inverse compatibility effect: the ER was lower when the masked spatial primes were incompatible with the required response (M= 4.67 %) than when they were compatible (M= 6.78%). No further effects or interactions were significant, for masked or unmasked spatial primes / valence targets. In the conditions with valence primes / spatial targets, the follow-up ANOVAs revealed a target response-compatibility effect when the valence primes were masked ($F[1,14] = 6.84$, $p < .05$, partial $\eta^2 = .328$) and unmasked ($F[1,14] = 5.45$, $p < .05$, partial $\eta^2 = .280$) respectively. This effect indicated that less mistakes were made when the spatial targets were response-compatible than when they were response-incompatible. (See Table 8 below)

Table 8.

Means and standard deviations of the significant effects in follow-up ER analyses of Group 1.

			M	SD
Masked spatial primes / valence targets	Prime-response compatibility	compatible	6.78	1.65
		incompatible	4.66	1.26
Masked valence primes / spatial targets	Target-response compatibility	compatible	4.56	0.94
		incompatible	7.33	1.11
Unmasked valence primes / spatial targets	Target-response compatibility	compatible	4.56	1.13
		incompatible	8.22	1.51

Note. Values present error rate in percent. The ERs show a prime-response compatibility effect for masked spatial primes/ valence targets (less mistakes in incompatible conditions). For masked and unmasked valence primes /spatial targets the target-response compatibility effect is as expected.

5.2.3. Group 2 Reaction Times

Participants in group 2 were required to press the right key for valence targets and the left key for spatial targets. Only 14 participants are included in this group, because one left-handed participant had to be excluded, in order to account for Casasanto's (2009) body specificity hypothesis. The results for this group were analyzed in an identical fashion as group 1 was analyzed, first with a 2 × 2 × 2 × 2 repeated measures ANOVA (the within factors were visibility, prime type, prime-response compatibility, and target-response compatibility) and then with four separate follow up ANOVAs (for masked spatial primes, unmasked spatial primes, masked valence primes, and unmasked valence primes). The 2 × 2 × 2 × 2 repeated measures ANOVA divulged a significant main effect of visibility: $F(1,13) = 7.09$, $p < .05$, partial $\eta^2 = .353$, that showed faster RTs for unmasked primes than for masked primes. There was also as significant main effect of prime type: $F(1,13) = 8.21$, $p < .05$, partial $\eta^2 = .387$, that showed that spatial primes / valence targets were processed faster than valence primes /spatial targets (See Table 9 for the means and SDs). There was also a significant three-way interaction of visibility, prime type and target-response compatibility, $F(1,13) = 6.25$, $p < .05$, partial $\eta^2 = .325$, that could explain or be responsible for the significant main effects. This three-way interaction shows that for masked valence primes the RTs to the spatial targets are faster, when the targets are response-compatible, than when they are response-incompatible. By contrast, for masked spatial primes the RTs to the valence targets are pretty much the same whether the targets are response-compatible or not. RTs to target-response incompatible masked spatial primes / valence targets are slower, than incompatible masked valence primes / spatial targets, whereas in the compatible conditions the RTs for masked spatial primes and masked valence primes are very similar. When the primes were visible, then responses were faster in the target-response compatible conditions, than in the target-response incompatible conditions, for both the spatial and the valence targets, and both the target-response compatible as well as the target-response incompatible targets led to slower RTs for the valence primes / spatial targets than for spatial primes /valence targets. (See Figures 19 and 20 for detail)

Table 9.

Means and standard deviations of the main effects for overall RT analysis of Group 2

		M	SD
Visibility	masked	725	16.2
	unmasked	697	11.3
Prime type	spatial	695	12.6
	valence	727	15.6

Note. Values represent reaction times in ms.

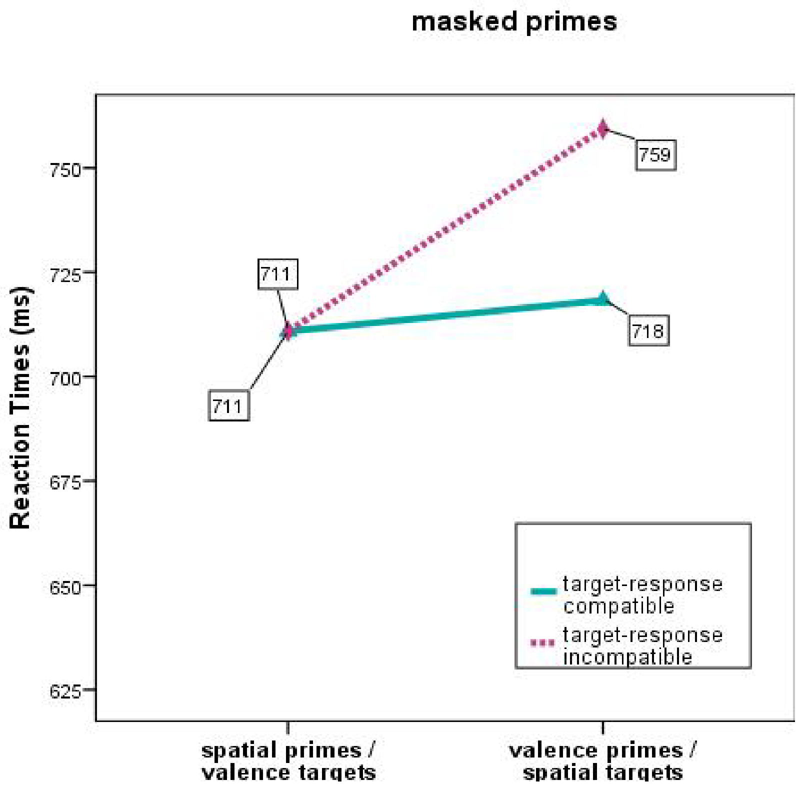

Figure 19. Three-way interaction between prime type / target type and target-response compatibility for masked primes in overall RT analysis of Group 2. Target response compatibility effect (faster RT in compatible than incompatible conditions) for valence primes/spatial targets, but not for spatial primes /valence targets.

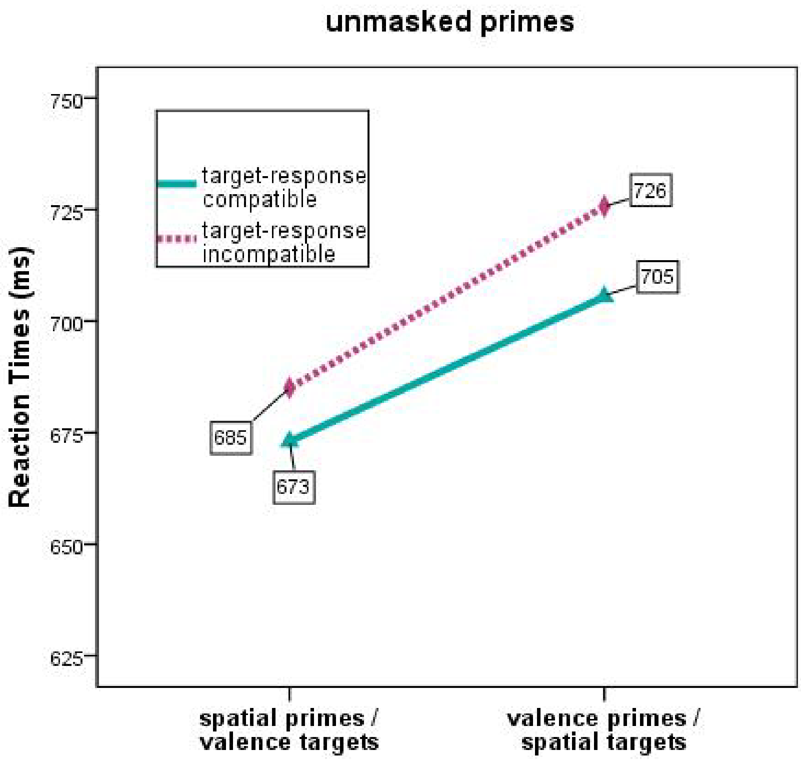

Figure 20. Three-way interaction between prime type / target type and target-response compatibility for unmasked primes in overall RT analysis of Group 2. Participants react relatively consistently slower in the target response incompatible conditions than the target-response compatible for both spatial primes /valence target and valence primes /spatial targets.

The repeated measures ANOVA also showed an almost significant main effect of target compatibility ($F[1,13] = 4.54$, $p = .053$, partial $\eta^2 = .259$) such that targets that were compatible with the response resulted in faster RTs (M = 702ms), compared to incompatible targets (M = 720ms), and an almost significant interaction between visibility and prime-response compatibility ($F[1,13] = 4.37$, $p = .057$, partial $\eta^2 = .252$). This almost significant interaction between visibility and prime-response compatibility showed that, not only were responses generally faster in the unmasked conditions compared with the masked conditions, but also that when primes were masked, participants tended to react faster to the response-compatible primes than the response incompatible primes. This prime-response compatibility disappeared when then the primes were visible. (See Figure 21 below).

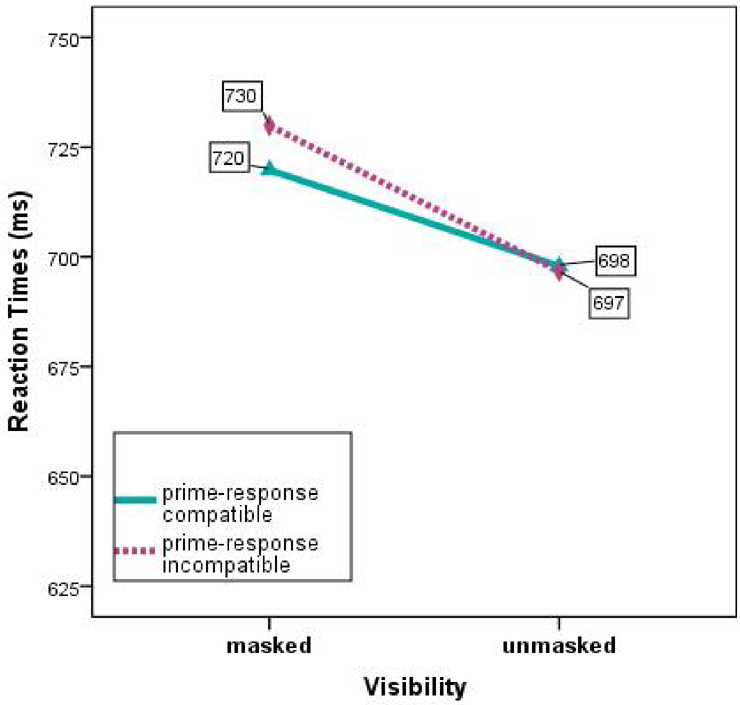

Figure 21. Almost significant interaction between visibility and prime-response compatibility in overall RT analysis of Group 2

This almost significant interaction between visibility and prime-response compatibility was also reflected in the follow-up ANOVAs for masked spatial primes (valence targets), which revealed a significant main effect of prime-response compatibility, $F(1,13) = 9.21$, $p = .01$, partial $\eta^2 = .415$, that indicated that the masked spatial primes / with valence targets yielded faster reaction times when the primes were compatible to the response than when they were incompatible to the response. On the other hand analysis of masked valence primes (spatial targets) with the follow-up ANOVA uncovered a very powerful, significant target-response compatibility effect: $F(1,13) = 11.76$, $p < .01$, partial $\eta^2 = .475$, that showed that when the valence primes were masked, and the targets were spatial, then RTs were faster to response compatible (spatial) targets (M =718), compared to response-incompatible targets (M=759). Furthermore only the masked conditions showed significant response-compatibility effects, whereas there were no significant effects for the unmasked conditions.

Table 10.

Significant main effects of follow-up analyses for RT analysis Group 2

			M	SD
Masked spatial primes / valence targets*	Prime-response compatibility	compatible	702	16.2
		incompatible	719	19.1
Masked valence primes / spatial targets°	Target-response compatibility	compatible	718	15.1
		incompatible	759	21.8

Note. Values represent reaction times in ms. Both the prime- and the target-response compatibility show, that RTs are faster in the compatible conditions.
*p<.05, °p<.01

5.2.4. Group 2 Error-rate

The error-rates of the participants in group 2 were also analyzed in the same fashion. The repeated measures ANOVA of the ERs over all conditions revealed a significant main effect of prime type: $F(1,13) = 4.92$, $p < .05$, partial $\eta^2 = .274$, that showed that participants made less mistakes responding to spatial primes / valence targets than to valence primes / spatial targets. There was also a significant main effect of target-response compatibility: $F(1,13) = 5.04$, $p < .05$, partial $\eta^2 = .279$, which was an inverse compatibility effect because the target-response incompatible conditions produced less mistakes compared to the compatible conditions. This inverse compatibility effect was also reflected in an almost significant prime-response compatibility effect: $F(1,13) = 4.45$, $p = .054$, partial $\eta^2 = .257$, which showed that ERs were higher when primes were incompatible with the response, than when they were compatible with the response. (See Table 11). There was also a significant interaction between visibility and prime type: $F(1,13) = 8.44$, $p < .05$, partial $\eta^2 = .394$, that showed that participants had similar ER for both spatial primes /valence targets and valence primes / spatial targets, when the primes were masked, but their error-rates increased drastically when the valence primes were visible, while their error-rate decreased when the spatial primes were visible. Also relevant is the almost significant interaction between target-response compatibility and prime-response compatibility: $F(1,13) = 4.60$, $p = .051$, partial $\eta^2 = .261$, that is reflected in the follow-up analysis of masked valence primes / spatial targets.

Table 11

Means and standard deviations of Significant and almost significant main effects of overall ER analysis Group 2

		M	SD
Prime type*	spatial	4.35	0.69
	valence	6.40	0.83
Target-response compatibility*	compatible	6.46	0.73
	incompatible	4.29	0.81
Prime-response compatibility^	compatible	5.98	0.73
	incompatible	4.76	0.60

Note. Values represent error-rates in percent.
*p<.05. ^p>.05

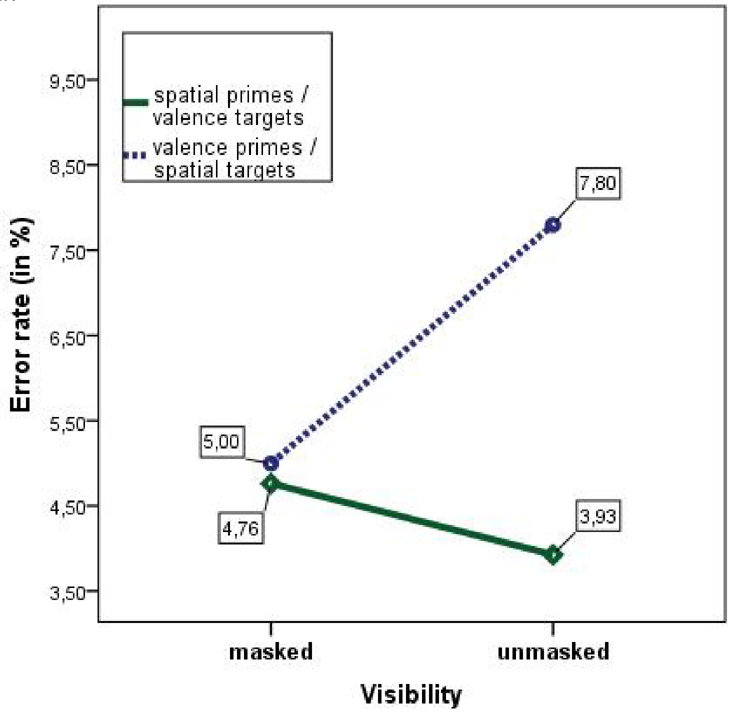

Figure 22. Significant interaction between prime type /target type and visibility in overall ER analysis Group 2.

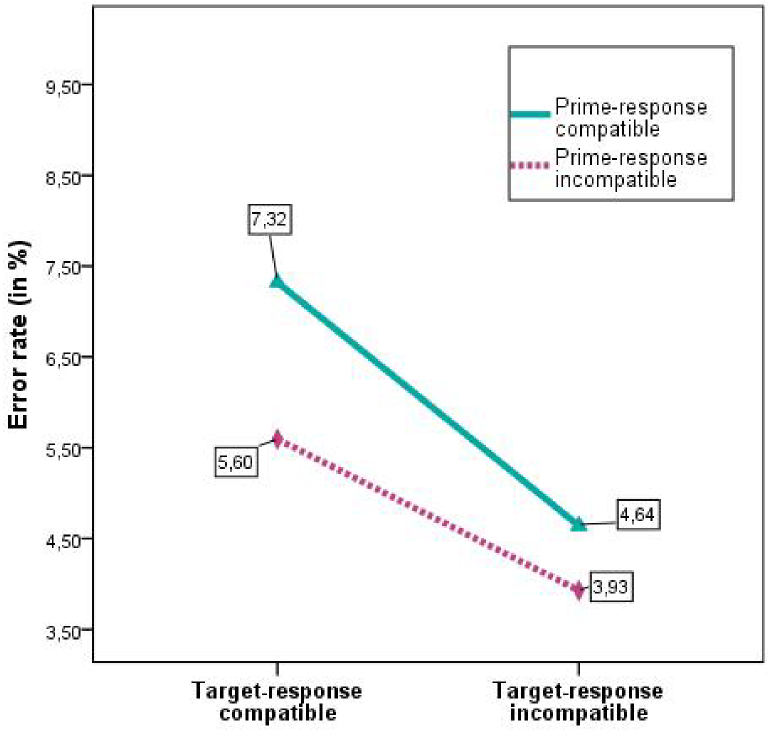

Figure 23. Almost significant interaction between target-response compatibility and prime response compatibility in overall ER analysis Group 2.

The follow-up ANOVAs analyzing the prime-response compatibility and the target-response compatibility for each prime type separately (both in the masked and unmasked conditions), just like in the previous sections, disclosed no significant response-compatibility effects for both the masked and unmasked spatial primes / valence targets. However in the conditions with masked valence primes, there was a significant inverse prime-response compatibility effect: $F(1,13) = 4.78$, $p < .05$, partial $\eta^2 = .269$, that showed that more mistakes were made when the primes were compatible with the response, than when the primes were response-incompatible. There was also a significant inverse target-response compatibility effect, $F(1,13) = 5.87$, $p < .05$, partial $\eta^2 = .311$, that showed that the participants also made more mistakes when the targets were compatible with the response, compared to when they were incompatible. (See Table 12) However these main effects could also be explained in part due to the significant interaction prime-response compatibility and target-response compatibility: $F(1,13) = 7.55$, $p < .05$, partial $\eta^2 = .367$, which shows that when the targets are response-compatible, the response compatible seem to give rise to more errors than the incompatible primes. This suggests that the response compatible primes might trigger a reaction that becomes particularly confusing or conflicts with the triggered response when the target is also response-compatible. (See Figure 24). The follow-up analyses also unearthed a significant inverse prime-response compatibility effect for the unmasked valence primes: $F(1,13) = 4.84$, $p < .05$, partial $\eta^2 = .271$, again participants responded with less mistakes in the prime-response incompatible conditions (M = 8.93%) compared to the prime-response compatible conditions (M=6.67%).

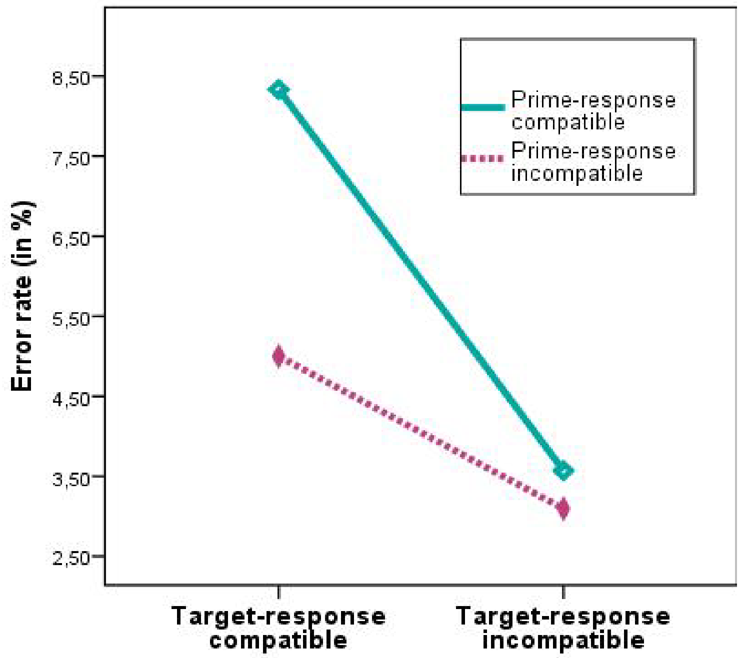

Figure 24. Significant interaction between prime-response compatibility and target-response compatibility in ER follow-up analysis for masked valence primes / spatial targets Group 2.

Table 12.

Significant main effects of ER follow-up analysis for masked valence primes / spatial targets Group 2

		M	SD
Prime-response compatibility	spatial	5.95	1.00
	valence	4.05	0.76
Target-response compatibility	compatible	6.67	0.89
	incompatible	3.33	1.16

Note. Values represent error-rates in percent.
*p<.05. ^p>.05

5.3. Discussion response-mapping

When the primes were spatial and the targets valence, the interaction between prime type /target type and target-response compatibility that was revealed in the overall repeated measures ANOVA of the reaction times as well as the error-rates in Group 1, showed that, contrary to what was predicted, participants responded faster and with less mistakes when the valence targets were response-incompatible as opposed to when they were compatible. This was also reflected in the follow-up analyses of the reaction times for Group 1, which showed that there was a significant inverse target-response compatibility effect for valence targets (spatial primes), in both masked and unmasked conditions. These inverse target-response compatibility effects towards valence targets could be explained in line with Eder and Klauer (2007), who investigated the stimulus-response compatibility effects between positively and negatively valenced stimuli and action planning of left and right button presses in a dual-task setting. The authors found what they termed an action-valence blindness effect, such that “affectively charged actions like negative and positive button presses [...] selectively impairs simultaneous evaluations of stimuli [...] with the same valence” (Eder & Klauer, 2007, p.1312). They argue, that because evaluation of valence and motor presentations are bound together, the access to one or the other is impaired when they overlap/coincide, thus reducing the ability to prepare the according motor response. Thus because the affective evaluation of the stimuli, and the action suggested by the stimulus-response effect use the same cognitive pathways, they impede one another when both use the same pathway (compatible conditions), causing slower reaction times. While the present study investigates the automatic effects of stimulus-response compatibility, and not planned action effects with long exposure times, the action-valence blindness effect could potentially be extended to explain the reverse compatibility effects found herein with valence targets. Ironically, while earlier cognitive facilitation of associated concepts have been interpreted as indicative of the embodied nature of the mind, Eder and Klauer suggest that the selfsame embodied nature causes inhibition when tasks require the same response and pathways. (Eder and Klauer (2009), later substantiated their findings of action-valence blindness using lever movements).

Alternatively it is equally possible that the inverse target-response compatibility effects for valence targets (spatial primes) that were observed in Group 1, is actually due to a tendency to react faster to positive stimuli. This possibility is in line with Schmidt, Patnaik, and Kensinger (2011), who found that participants were more likely to remember positive than negative stimuli (p. 241). In Group 1, participants had to respond with their left finger if the targets were valent. In this case, if the targets were positive this would be the target-response incompatible reaction. If people generally react faster to positive stimuli, then this would explain the inverse target-response compatibility effects. It is equally possible, that these effects, could be due to the processing of the spatial primes, or due the effect that the processing of the spatial primes have on the valence targets, even if strictly speaking they are target-response compatibility effects. This is underlined by the inverse prime-response compatibility in the ER for masked spatial primes in Group 1. As previously mentioned, not only is there a stimulus-response effect, but the stimulus-response effect also affects the stimulus-stimulus processing (cf. Virzi & Egeth, 1985)

None of these possible explanations for the recurring inverse target-response compatibility effects for spatial primes / valence targets in Group 1, would however explain the complete lack of a target-response compatibility effects for spatial primes /valence targets in Group 2. In this group, merely a prime-response compatibility effect for masked spatial primes /valence targets was found, that showed that participants reacted faster when the spatial primes were compatible with the response. At present, there seems to be no explanation that could reconcile these results. Even if one were to assume that the inverse target response compatibilities for spatial primes / valence targets in Group 1 were due to the spatial primes, as supported by the almost significant inverse prime-response compatibility in the follow-up RT analysis for the masked spatial primes, and the inverse prime response compatibility effect in the follow-up ER analysis of the masked spatial primes, this would still not explain why in Group 2 the prime-response compatibility effect was as expected.

Notwithstanding the lack of significant orthogonal stimulus-response compatibility effects in the RT-analysis of valence primes / spatial targets in Group 1, the findings under these conditions seem to be a slightly more consistent. In the conditions that presented valence primes / spatial targets there were target-response compatibility effects in the ER-analysis of this Group 1 for the spatial targets with both the masked and unmasked conditions: participants made fewer mistakes in the target-response compatible as compared to the incompatible conditions (fewer mistakes to up-targets with right hand). This target-response compatibility for spatial targets (valence primes) was also confirmed in the RT analysis of Group 2, where there was a significant target-response compatibility effect for masked valence primes / spatial targets (faster RTs for down-targets with left hand). However, there was also an inverse target-response compatibility effect for the masked valence primes /spatial targets in the ER analysis of Group 2, which means more mistakes were made in the compatible conditions (down target with left response) than in the incompatible conditions (up target with left response), which could indicate a speed-accuracy tradeoff. This incompatibility effect could however also be due to the significant inverse-prime response compatibility effects for both masked and unmasked valence primes (spatial targets), and the significant interaction of target-response compatibility and prime-response compatibility for masked valence primes, which suggest that prime-response compatible primes may have triggered a response that conflicted with the target-response congruent responses, resulting in more errors. Therefore this discrepancy in the ER of Group 2 could be due to the action-valence blindness effect, or a similar competition effect, that causes more mistakes when two different subsequent stimuli activate a certain response. (cf. Eder & Klauer 2007, 2009)

In general, it is not possible to reconcile the effects found in Group 1 and Group 2 in a satisfactory manner that would account for the differences between these groups. This is particularly true for the conditions in which the primes were spatial and the targets valence. The inability to account for a consistent orthogonal compatibility effect with the valent targets is not surprising, considering that there is far less research to substantiate this effect than there is with spatial stimulus-response compatibility. Furthermore, as explained in the discussion for metaphor congruence, it is possible that the dimensional aspect of the valence primes /targets were successfully ignored as per the task requirement, and therefore didn’t cause the response compatibility effects. Even though the results for the stimulus-response compatibility effects for valence primes /spatial are not quite as conflicted, they seem far from definitive or conclusive.

Therefore, unless there were unique effects caused by the mapping assignments of the groups due to, say a tendency to respond better to spatial targets with the right hand, that is then compounded with potential stimulus-response compatibility effects, there were no truly robust response-compatibility effects that could have biased the metaphor-congruence effects in a consistent manner. This finding is in line with the one put forth by Ansorge et al. (2010), who also tested the congruence-effect of spatial primes and targets, and found no orthogonal compatibility effects with left and right keyresponses.

All the same, the stimulus-response compatibilities may have influenced the responses in an unsystematic fashion, or perhaps there was an interactive effect between the stimulus-response compatibility and metaphor-congruence that has, to date, not been examined.

6. Overall Discussion and Suggestions for Future Research

In the present study the only indication of the anticipated metaphor-congruence effect was reflected in the significant interaction between prime type / target type and metaphor-congruence that was revealed in the error-rate analysis. This showed a slight congruence effect of spatial primes / valence targets and an inverse congruence effect (more errors in the metaphor congruent conditions) for valence primes / spatial targets. However, this interaction alone does not provide enough evidence to conclusively substantiate the assumption that vertical space and valence are linked in a metaphor-congruent fashion, and that this link can be accessed in an automatic semantic fashion.

The analysis of the stimulus-response compatibilities revealed many significant results, which were however inconsistent. Especially the results from the two groups were so irreconcilably contradictory with each other, that it can be assumed that the orthogonal stimulus-response compatibility did not bias the responses in a systematic fashion. However it is not possible to completely discard stimulus response-compatibility effects as confounding factors. In this context it would be particularly interesting to investigate the relation between the stimulus-response compatibilities and metaphor-congruence in future studies.

Furthermore, there may be other ways to circumvent a short-term learned category congruency effect, than the one used in the present study. Here, setting a categorization task that required a stimulus evaluation completely independent of the attributes under investigation might have caused these dimensional attributes to be ignored. Perhaps future studies will find a better way to bridge these two issues. Another potential influence on the results for the present study could be the choice of stimuli. While the spatial words were adapted from Ansorge et al. 2011, the complete list was not investigated for perceptual similarity or word/syllable length. Also, the valence words were not controlled for arousal, which as previous studies have shown can have profound effects (for the effects of emotion and arousal on spatial memory see Schmidt, Patnaik, & Kensinger, 2011).

Finally, several difficulties arise from the necessity to test for the prime-visibility. For one participants reacted adversely when they had to perform a metaphor-congruence assessment based on primes that they didn’t see. Furthermore the metaphor-congruence task did draw attention to this aspect of the study. There may be a better way to directly assess visibility.

Future research may also attempt to investigate this metaphoric link on a behavioral level, but also using brain imaging techniques and ERP measures such as Hauk et al. (2004) or Kiefer (2002).

References

Abrams, R. L., Klinger, M. R., & Greenwald, A. G. (2002). Subliminal words activate semantic categories (not automated motor responses). *Psychonomic Bulletin & Review, 9*(1), 100-106.

Ansorge, U., Fuchs, I., Khalid, S., & Kunde, W. (2011). No conflict control in the absence of awareness. *Psychological Research, 75*(5), 351-365. doi: 10.1007/s00426-010-0313-4

Ansorge, U., Kiefer, M., Khalid, S., Grassl, S., & König, P. (2010). Testing the theory of embodied cognition with subliminal words. *Cognition, 116*(3), 303-320. doi: 10.1016/j.cognition.2010.05.010

Barsalou, L. W. (1999). Perceptual symbol systems. *Behavioral and Brain Sciences, 22*, 577–660.

Barsalou, L. W. (2008). Grounded Cognition. *Annual Review of Psychology, 59*(1), 617-645. doi: 10.1146/annurev.psych.59.103006.093639

Bauer, D. W., & Miller, J. (1982). Stimulus-response compatibility and the motor sytem. *Quarterly Journal of Experimental Psychology: Section A-Human Experimental Psychology, 34*, 367-380.

Brunel, N., & Lavigne, F. (2008). Semantic Priming in a Cortical Network Model. *Journal of Cognitive Neuroscience, 21*(12), 2300-2319.

Casasanto, D. (2009). Embodiment of abstract concepts: Good and bad in right- and left-handers. *Journal of Experimental Psychology: General, 138*(3), 351-367. doi: 10.1037/a0015854

Casasanto, D., & Chrysikou, E. G. (2011). When Left Is "Right": Motor Fluency Shapes Abstract Concepts. *Psychological Science, 22*(4), 419-422. doi: 10.1177/0956797611401755

Cho, Y. S., & Proctor, R. W. (2003). Stimulus and response representations underlying orthogonal stimulus-response compatibility effects. *Psychonomic Bulletin & Review, 10*, 45-73.

Craft, J. L., & Simon, J. R. (1970). Processing symbolic information from a visual display - interference form an irrelevant directional cue. *Journal of Experimental Psychology, 83*(3), 415-420. doi: 10.1037/h0028843

Crawford, L. E. (2009). Conceptual Metaphors of Affect. *Emotion Review, 1*(2), 129-139. doi: 10.1177/1754073908100438

Crawford, L. E., Margolies, S. M., Drake, J. T., & Murphy, M. E. (2006). Affect biases memory of location: Evidence for the spatial representation of affect. *Cognition & Emotion, 20*(8), 1153-1169. doi: 10.1080/02699930500347794

Damian, M. F. (2001). Congruity effects evoked by subliminally presented primes: automaticity rather than semantic processing. *Journal of Experimental Psychology: Human Perception and Performance, 27*(1), 154-165.

De Houwer, J., Hermans, D., Rothermund, K., & Wentura, D. (2002). Affective priming of semantic categorisation responses. *Cognition & Emotion, 16*(5), 643-666. doi: 10.1080/02699930143000419

Dehaene, S., Naccache, L., Le Clec'H, G., Koechlin, E., Mueller, M., Dehaene-Lambertz, G., . . . Le Bihan, D. (1998). Imaging unconscious semantic priming. *Nature, 395*(6702), 597-600. doi: 10.1038/26967

Eder, A. B., & Klauer, K. C. (2007). Common valence coding in action and evaluation: Affective blindness towards response-compatible stimuli. *Cognition & Emotion, 21*(6), 1297-1322. doi: 10.1080/02699930701438277

Eder, A. B., & Klauer, K. C. (2009). A common-coding account of the bidirectional evaluation–behavior link. *Journal of Experimental Psychology: General, 138*(2), 218-235. doi: 10.1037/a0015220

Gibbs, R. W., Jr. (1992). Categorization and Metaphor Understanding. *Psychological Review, 99*, 572-577.

Giessner, S. R., & Schubert, T. W. (2007). High in the hierarchy: How vertical location and judgments of leaders' power are interrelated. *Organizational Behavior and Human Decision Processes, 104*(1), 30-44. doi: 10.1016/j.obhdp.2006.10.001

Glucksberg, S. (2003). The psycholinguistics of metaphor. *Trends in Cognitive Sciences, 7*(2), 92-96. doi: 10.1016/s1364-6613(02)00040-2

Glucksberg, S., Gildea, P., & Bookin, H. B. (1982). On understand non-literal speech: Can people ignore metaphors? *Journal of Verbal Learning and Verbal Behavior, 21*(1), 85-98. doi: 10.1016/s0022-5371(82)90467-4

Glucksberg, S., & Keysar, B. (1990). Understanding metaphorical comparisons: Beyond similarity. *Psychological Review, 97*(1), 3-18. doi: 10.1037//0033-295x.97.1.3

Glucksberg, S., Keysar, B., & McGlone, M. S. (1992). Metaphor Understanding and Accessing Concetptual Schema: Reply to Gibbs 1992. *Psychological Review, 99*, 578-581.

Hacking, I. (2001). Aristotelian categories and cognitive domains. *Synthese, 126*(3), 473-515.

Hauk, O., Johnsrude, I., & Pulvermüller, F. (2004). Somatotopic representation of action words in human motor and premotor cortex. *Neuron, 41*(2), 301-307. doi: 10.1016/s0896-6273(03)00838-9

Havas, D. A., Glenberg, A. M., & Rinck, N. (2007). Emotion simulation during language comprehension. *Psychonomic Bulletin & Review, 14*(3), 436-441. doi: 10.3758/bf03194085

Holender, D., & Duscherer, K. (2004). Unconscious perception: The need for a paradigm shift. *Perception & Psychophysics, 66*(5), 872-881.

Horstmann, G., & Ansorge, U. (2011). Compatibility between tones, head movements, and facial expressions. *Emotion, 11*(4), 975-980. doi: 10.1037/a0023468

Hutchison, K. A. (2003). Is semantic priming due to association strength or feature overlap? A microanalytic review. *Psychonomic Bulletin & Review, 10*(4), 785-813. doi: 10.3758/bf03196544

Khalid, S., König, P., & Ansorge, U. (2011). Sensitivity of different measures of the visibility of masked primes: Influences of prime–response and prime–target relations. *Consciousness and Cognition, 20*(4), 1473-1488. doi: 10.1016/j.concog.2011.06.014

Kiefer, M. (2002). The N400 is modulated by unconsciously perceived masked words: further evidence for an automatic spreading activation account of N400 priming effects. *Cognitive Brain Research, 13*, 27-39.

Kiefer, M., & Brendel, D. (2006). Attentional modulation of unconscious "automatic" semantic processes: Evidence from event-related potentials in a masked priming paradigm. *Journal of Cognitive Neuroscience, 18*(2), 184–198.

Kinoshita, S., & Hunt, L. (2008). RT distribution analysis of category congruence effects with masked primes. *Memory & Cognition, 36*(7), 1324-1334. doi: 10.3758/mc.36.7.1324

Klauer, K. C., Eder, A. B., Greenwald, A. G., & Abrams, R. L. (2007). Priming of semantic classifications by novel subliminal prime words. *Consciousness and Cognition, 16*(1), 63-83. doi: 10.1016/j.concog.2005.12.002

Kouider, S., & Dehaene, S. (2007). Levels of processing during non-conscious perception: a critical review of visual masking. *Philosophical Transactions of the Royal Society B: Biological Sciences, 362*(1481), 857-875. doi: 10.1098/rstb.2007.2093

Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh: The embodied mind and its challenge to western thought*. New York, NY: Basic Books.

Lippa, Y., & Adam, J. (2001). An explanation of orthogonal S-R compatibility effects that vary with hand or response position: The end-state comfort hypothesis. *Attention, Perception, & Psychophysics, 63*(1), 156-174. doi: 10.3758/bf03200510

Lu, C.-H., & Proctor, R. W. (1995). The influence of irrelevant location information on performance: A review of the Simon and spatial Stroop effects. *Psychonomic Bulletin & Review, 2*(2), 174-207.

Lupker, S. J., & Davis, C. J. (2009). Sandwich priming: A method for overcoming the limitations of masked priming by reducing lexical competitor effects. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35*(3), 618-639. doi: 10.1037/a0015278

Marcel, A. J. (1983). Conscious and Unconscious Perception: Experiments on Visual Masking and Word Recognition. *Cognitive Pychology, 15*, 197-237.

McClain, L. (1983). Stimulus-response compatibility affects auditory stroop interference. *Perception & Psychophysics, 33*(3), 266-270. doi: 10.3758/bf03202864

McErlee, B., & Nordlie, J. (1999). Literal and figurative interpretations are computed in equal time. *Psychonomic Bulletin & Review, 6*(3), 486-494.

Meier, B. P., Hauser, D. J., Robinson, M. D., Friesen, C. K., & Schjeldahl, K. (2007). What's "up" with God? Vertical space as a representation of the divine. *Journal of Personality and Social Psychology, 93*(5), 699-710. doi: 10.1037/0022-3514.93.5.699

Meier, B. P., & Robinson, M. D. (2004). Why the Sunny Side Is Up: Associations Between Affect and Vertical Position. *Psychological Science, 15*(4), 243-247. doi: 10.1111/j.0956-7976.2004.00659.x

Meier, B. P., & Robinson, M. (2006). Does “feeling down” mean seeing down? Depressive symptoms and vertical selective attention. *Journal of Research in Personality, 40*(451–461). doi: 10.1016/j.jrp.2005.03.001

Moeller, S. K., Robinson, M. D., & Zabelina, D. L. (2008). Personality Dominance and Preferential Use of the Vertical Dimension of Space: Evidence From Spatial Attention Paradigms. *Psychological Science, 19*(4), 355-361. doi: 10.1111/j.1467 -9280.2008.02093.x

Naccache, L., & Dehaene, S. (2001). Unconscious semantic priming extends to novel unseen stimuli. *Cognition, 80*, 215-229.

Niedenthal, P. M., Barsalou, L. W., Winkielman, P., Krauth-Gruber, S., & Ric, F. (2005). Embodiment in Attitudes, Social Perception, and Emotion. *Personality and Social Psychology Review, 9*(3), 184-211. doi: 10.1207/s15327957pspr0903_1

Proctor, R. W., & Cho, Y. S. (2003). Effects of response eccentricity and relative position on orthogonal stimulus-response compatibility with joystick and keypress responses. *Quarterly Journal of Experimental Psychology Section a-Human Experimental*

Psychology, 56(2), 309-327. doi: 10.1080/02724980244000350

Proctor, R. W., & Wang, H. F. (1997). Set- and element-level stimulus-response compatibility effects for different manual response sets. *Journal of Motor Behavior, 29*(4), 351-365.

Quinn, W. M., & Kinoshita, S. (2008). Congruence effect in semantic categorization with masked primes with narrow and broad categories. *Journal of Memory and Language, 58*(2), 286-306. doi: 10.1016/j.jml.2007.03.004

Reingold, E. M., & Merikle, P. M. (1988). Using direct and indirect measures to study perception without awareness. *Perception & Psychophysics, 44*(6), 563-575. doi: 10.3758/bf03207490

Rossell, S. L., Price, C. J., & Nobre, A. C. (2003). The anatomy and time course of semantic priming investigated by fMRI and ERPs. *Neuropsychologia, 41*(5), 550-564. doi: 10.1016/s0028-3932(02)00181-1

Schmidt, K., Patnaik, P., & Kensinger, E. A. (2011). Emotion's influence on memory for spatial and temporal context. *Cognition & Emotion, 25*(2), 229-243. doi: 10.1080/02699931.2010.483123

Schubert, T. W. (2005). Your highness: Vertical positions as perceptual symbols of power. *Journal of Personality and Social Psychology, 89*(1), 1-21. doi: 10.1037/0022-3514.89.1.1

Simon, J. R., & Rudell, A. P. (1967). Auditory S-R compatibility: The effect of an irrelevant cue on information processing. *Journal of Applied Psychology, 51*(3), 300-304. doi: 10.1037/h0020586

Stanislaw, H., & Todorov, N. (1999). Calculation of signal detection theory measures. *Behavior research methods, instruments, & computers, 31*(1), 137-149. doi: 10.3758/BF03207704

Stepper, S., & Strack, F. (1993). Proprioceptive Determinants of Emotional and Nonemotional Feelings. *Journal of Personality and Social Psychology, 64*(2), 211-220.

Strack, F., Martin, L. L., & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: A nonobstrusive test of the facial feedback hypothesis. *Journal of Personality and Social Psychology, 54*(5), 768-777. doi: 10.1037//0022-3514.54.5.768

VandenBos, G. R. (Ed.). (2007). *APA dictionary of psychology.* Washington, DC: American Psychological Association.

Van den Bussche, E., Van den Noortgate, W., & Reynvoet, B. (2009). Mechanisms of masked priming: A meta-analysis. *Psychological Bulletin, 135*(3), 452-477. doi: 10.1037/a0015329

Virzi, R. A., & Egeth, H. E. (1985). Toward a translational model of stroop interference. *Memory & Cognition*, *13*(4), 304-319. doi: 10.3758/bf03202499

Vu, K. P. L., & Proctor, R. W. (2004). Mixing compatible and incompatible mappings: Elimination, reduction, and enhancement of spatial compatibility effects. *The Quarterly Journal of Experimental Psychology Section A, 57*(3), 539-556. doi: 10.1080/02724980343000387

Wapner, S., Werner, H., & Krus, D. M. (1957). The effect of success and failure on space localization. *Journal of personality, 25*, 752-756.

*The image depicts a QWERTY keyboard. While participants in this study used a QWERTZ keyboard, the letters that were used for the experiment are at the same positions on both these keyboards, and the image is meant merely as a visual aid. The image was taken from the website: http://it.flexinet.com.au/Bits%20and%20Pieces/Keyboard/Keyboard.htm on June 22nd 2012, and used with express permission of the author of said website.

Curriculum Vitea

Daniela Egerer

Geboren 13.05.1983 in Wien, ledig
Staatsbürgerschaft: Österreich

Bildungsweg

seit Sommersemester 2003	**Studium der Psychologie** (gemeldet)**,** Universität Wien
seit Wintersemester 2007/2008	**Studium der Anglistik** (gemeldet), Universität Wien
August 2001-Februar 2003	**Studium der Psychologie,** Northeastern University in Boston, Massachssets, USA • Studiert im Rahmen des Honors Program • Mit Leistungsstipendium
1989-2001	**Schulbildung**, American International School of Vienna • Abschluss mit Matura bzw. Nostrifikation • Abschluss mit American High-School Diploma • Abschluss mit Zertifikaten des Internationalen Baccalaureats

Praktika

Sommer 2008	**Pflichtpraktikum des Psychologiestudiums,** sechs Wochen Absolviert auf der Psychiatrischen Abteilung, 6. Primariat des Otto-Wagner-Spitals

Berufliche Erfahrung

2001-2002	**Callcenter Arbeit** und **Community receptionist** Northeastern University
2005	**Kundenbetreuung und Kundenanwerbung** Firma Tinitronics
Sommer 2006	**Englischunterricht und Kinderbetreuung**, Sommerlagern der Firma Austrian Holidays

Ergänzende Bildung

1997 **Französisch Intensivkurs**, Institut Francais, in Wien

1998 **Französisch Intensivkurs**, Camp Ceran, in Belgien

2000 **National Leadership Camp**, American University, Washington DC
- Kurse über Amerikanisches Rechtssystem
- Workshops zur Förderung von Teamarbeit und Führungsfertigkeiten

2006 **Spanischkurs**, Lateinamerikanisches Institut, Wien

2010 **Spanisch Intensivkurs**, Samara Language School, Costa Rica

Besondere Kenntnisse und Fähigkeiten

Sprachen: Englisch – quasi 2. Muttersprache
Französisch – gut
Spanisch – Anfängerniveau

EDV Betriebssysteme: Windows, Linux

Office-Programme: Word, Excel, Open Office

Auswertungsprogramme: SPSS

Internet, E-Mail

Freizeitaktivitäten

Fußball: 1994-2001 in Schulmannschaften, einige Auszeichnungen
seit 1997 auch in Vereinen, zeitweise in 2. Liga Ost
zweimal Wiener Meister

Basketball: 1995-2001 in Schulmannschaften, seitdem vorwiegend privat

Softball : 1998-2001 in Schulmannschaften,
2011-2012 in Stahl Softball-Liga, Herbstmeister

Lesen, reisen und Zeit mit lieben Menschen verbringen